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ANALYSIS OF MONAZITE, ZIRCON, AND APATITE FROM THE SOUTHEASTERN PIEDMONT

NATIONAL URANIUM RESOURCE EVALUATION PROGRAM

**BARBARA S. KARFUNKEL, WILLIAM M. FAY,
AND VAN PRICE, JR.**

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NATIONAL URANIUM RESOURCE EVALUATION PROGRAM

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BARBARA S. KARFUNKEL, WILLIAM M. FAY,
AND VAN PRICE, JR.

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ABSTRACT

Two hundred sixty-three monazite, 191 zircon, and 16 apatite grains from 52 stream-sediment locations in the Southeastern Piedmont were analyzed by electron microprobe for one of the following suites of elements: Ca, La, Ce, Pr, Nd, Sm, Eu, Gd, Er, Dy, Y, Th, U, P, and F, or Ca, La, Ce, Fe, Er, Hf, Y, Th, U, P, Zr, Mg, Al, and Si. Monazite samples that had high uranium or thorium content and zircon samples that had high hafnium or iron content from a total of six locations were reanalyzed to confirm the initial results. This report contains a description of sample collection and preparation procedures, analytical methods, tables of analyses, and a statistical summary of analyses.

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INTRODUCTION

Since 1974, the Savannah River Laboratory (SRL) has been involved in the U.S. Department of Energy's National Uranium Resource Evaluation (NURE) program. The SRL role has been to design, conduct, and report data from a geochemical reconnaissance of nearly 4 million km² in 30 eastern and 7 western states. Samples of stream sediment, soil, and surface and ground water were analyzed by neutron activation techniques for uranium and other elements. The purpose of this work was to provide a basis for evaluating the uranium potential of these areas and to identify areas meriting conventional geologic followup.

This paper includes electron microprobe analyses of monazite, zircon, and apatite panned from stream sediments at 52 locations in the Southeastern Piedmont. Table 10 gives the location (longitude and latitude) of the sampling sites. The study was conducted to provide background data for interpretation of uranium, thorium, and rare-earth-element analyses of NURE reconnaissance samples. Eight traverses (A-H) were made across areas in Georgia, North Carolina, and South Carolina where uranium, thorium, and cerium concentrations were high as revealed by reconnaissance data (Figure 1). Panned stream-sediment samples were collected at several sites along each traverse following techniques similar to those described for U.S. Geological Survey evaluations of the Southeastern Monazite Belt (Overstreet, 1968). One objective of this procedure was to allow the development of models from NURE reconnaissance data for estimation of monazite resources.

SAMPLING PROCEDURES

Sample collection and preparation were done for SRL by Jerry Owen of Athens, Georgia. His report to SRL is included in this paper without final editing or corrections (Appendix A).

FIGURE 1. Traverses (A - H) Across Areas of High Cerium Concentrations in Stream Sediment Samples in the Southeastern U.S.

ANALYTICAL METHODS AND DATA

Analyses were performed by W. C. Mosley, Jr., with an ARL scanning electron microprobe quantometer (SEMQ). His report is included in this paper as Appendix B. Standards for each reported element are given in Table 1 of Appendix B. Usually, 10 grains each in the medium and high magnetic fractions of each sample were selected randomly for SEMQ analyses. Most analyses were made by scanning a 20- by 20-micron area in the grain. However, spot analyses were made in selected grains to determine compositional variations along lines within the grain or at randomly selected points.

Tables 1 and 2 give the data normalized to 100% and the raw oxide totals for monazite and zircon. Raw data for monazite lacking rare-earth-element analyses are given in Table 3 and raw data for apatite in Table 4. Table 5 contains spot analyses of monazite grains; for the B02 grains, spots were chosen at random, for the F0204 grain, spots 1-10 were analyzed along a line perpendicular to a second line containing spots 11-20. Analysis totals tend to vary with time of analysis and other analytical factors; thus, for interpretive purposes, we suggest that the normalized data be used. Tables 6-9 give the mean values, ranges in composition, and other statistical information for monazite, zircon, and apatite.

Samples containing high uranium monazites from sites E04 and G03 and high thorium monazites from A03 were reanalyzed by P. O'Rourke with the ARL SEMQ. The analyses of the oxides normalized to 100% are given in Table 11. In A03, three points were analyzed in one grain (7, 8, and 9, Figure 2) of which a thorium map was made (Figure 3). The results of the analyses for this grain correlate with the thorium distribution map of the grain and confirm the high thorium values of the initial analyses. Figures 4 and 5 show another monazite grain and corresponding thorium map.

FIGURE 2. Analysis Points in a Monazite Grain (600x) (A03, Grain 7)

FIGURE 3. Thorium Distribution Map of the Grain in Figure 2

FIGURE 4. Monazite Grain (500x) from E04

FIGURE 5. Thorium Distribution Map of the Grain in Figure 4

Samples with high-hafnium zircons from sites E07 and G02 and high-iron zircons from E03 were reanalyzed by J. C. Stormer at the University of Georgia in Athens. His report is included in this paper as Appendix C. The analyses of the oxides are given in Table 12. The locations of the analysis points are indicated in Figures 6, 7, and 8. High hafnium values indicated in Table 2 were not confirmed.

A grain of samarskite was identified from site A03. The grain and accompanying uranium-distribution map are shown in Figures 9 and 10. SEMQ analyses of two points on this grain yielded the following composition:

	<u>Weight % (oxide)</u>	
	<u>I</u>	<u>II</u>
La ₂ O ₃	0.00	0.00
Ce ₂ O ₃	0.00	0.00
Pr ₂ O ₃	0.09	0.16
Nd ₂ O ₃	0.21	0.16
Sm ₂ O ₃	0.00	0.00
SiO ₂	0.00	0.00
Y ₂ O ₃	9.97	9.87
P ₂ O ₅	0.00	0.00
ZrO ₂	0.31	0.27
F	1.42	0.00
ThO ₂	3.29	3.19
UO ₂	20.66	20.19
CaO	2.14	2.06
Eu ₂ O ₃	0.00	0.00
Gd ₂ O ₃	0.51	0.53
Er ₂ O ₃	4.27	3.40
Dy ₂ O ₃	1.68	1.60
FeO	1.10	1.10
Nb ₂ O ₅	16.57	15.67
Ta ₂ O ₅	1.28	1.36

FIGURE 6. Analysis Areas (grey triangles)
in E03, Grain 1 (250x)

FIGURE 7. Analysis Areas (dark grey dots)
in E07 (250x)

FIGURE 8. Analysis Areas (grey triangles)
in G02, Grain 13 (400x)

FIGURE 9. Samarskite Grain in A03 (250x)

FIGURE 10. Uranium Distribution Map of the Samarskite Grain in Figure 9 (250x)

REFERENCE CITED

Overstreet, W. C., White, A. M., Whitlow, J. W., Theobald, P. K., Jr., Caldwell, O. W., and Cuppels, N. P., 1968, Fluvial monazite deposits in the Southeastern United States: U.S. Geological Survey Professional Paper 568.

APPENDIX A
SAMPLING PROCEDURE AND PREPARATION

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November 1979

The purpose of this project was to collect approximately 50 sediment samples from streams in portions of Georgia, South Carolina, and North Carolina. The heavy minerals were separated from the -100 mesh portion of each sample, and three magnetic splits were made on each heavy-mineral concentration. The separation of monazite from the other heavy minerals was the desired result.

A computer-drawn thorium concentration contour map having an area of six 1° by 2° sheets was used to define the highest concentrations of monazite in the study area. Traverses across the eight highest thorium concentrations were reproduced on county road maps having scales of 1 inch = 1 mile or 1 inch = 2 miles. These maps were used during the field work and to plot the sampling locations.

The desired number of samples (50) and the total length of the traverses gave a sample density of one sample for approximately each 7 miles of traverse length. In order to include as many streams as possible, composite samples from adjacent streams were taken. Most of the samples are made up of sediment taken from two to four adjacent streams. The samples were commonly taken within 2 miles on either side of the traverse line. Each subsample is listed with a letter attached to the sample number in that traverse. (Example: A-1a, A-1b, A-1c, etc.) The "A" refers to the particular traverse, as shown on the contour map of thorium values. The "1" refers to the first sample on that traverse, and the "a," "b," "c," etc., refer to the particular stream where the sediment was taken.

Approximately equal amounts of sediment were taken from each stream to make a total of 10 quarts per sample. The amount coming from each stream depended upon the number of streams per sample. (Example: 2 streams per

sample--5 quarts per stream, 4 streams per sample--2.5 quarts per stream, etc.)

A total of 52 10-quart samples was taken, representing 156 streams. Each sample was sieved in the field to approximately 14 mesh. The remainder of the sample was brought back to the laboratory and dried.

Each sample was then machine sieved on a Ro-Tap to -100 mesh. The -40 to +100 mesh portion, and the -100 mesh portion were retained; the rest was discarded.

The -100 mesh portion was weighed and then panned. The remaining concentrate was dried, and a heavy-mineral separation using Bromoform liquid was done. The heavy-mineral concentration was weighed, then placed in the Frantz Isodynamic separator for a magnetic separation.

The entire sample was first split at 0.4 amps, giving two splits: one <0.4, the other >0.4. The >0.4 amps split was passed through again at 0.7 amps, giving two splits: one <0.7, one >0.7 amps. Thus, three splits were taken from each sample: <0.4 amps, 0.4 to 0.7 amps, and >0.7 amps. (Note: Sample C-4 had only 75 grams magnetically separated from it due to the size of the sample--414.8 grams.)

An 11° cross tilt and a 15° vertical tilt were used on the magnetic separator.

Table 1 lists sample number, approximate stream size where sample was taken, weight, and sample location for each sample.

The included eight sets of maps show sample locations.

TABLE 1

Sample No.	-100 mesh wt. (gms)	Heavy mineral conc. wt. (gms)	Approx. stream depth (inches)	Approx. stream width (feet)	Location	
A-1a			2-3	1	Hancock Co., Georgia	
A-1b	329.7	35.0	6	6	"	"
A-1c			6	3	"	"
A-1d			8	6	"	"
A-2	47.9	10.3	10	8	"	"
A-3a			4	5	Greene Co., Georgia	
A-3b	53.9	7.5	6	4	"	"
A-3c			4	2-3	"	"
A-3d			4	2-3	"	"
A-3e			6	6	"	"
A-4a			4	2	"	"
A-4b	231.7	7.4	18	15	"	"
A-4c			18	15	"	"
A-4d			4	3	"	"
A-5a			12	15	"	"
A-5b	219.4	13.7	24	20	"	"
A-5c			12	12-15	"	"
A-5d			3	3	"	"
A-6a			12	15	Oconee Co., Georgia	
A-6b	63.5	7.0	15	12	"	"
A-6c			12	15	"	"
A-7a			8	1.5	"	"
A-7b	85.5	9.9	12	15	"	"
A-7c			8	3	"	"

TABLE 1. (cont.)

Sample No.	-100 mesh wt. (gms)	Heavy mineral conc. wt. (gms)	Approx. stream depth (inches)	Approx. stream width (feet)	Location
A-8a	143.9	12.7	8	3-4	Oconee Co., Georgia
A-8b			18	18-20	" "
A-8c			6	10	" "
A-8d			6	1.5	" "
A-9a	192.5	10.4	4	1	" "
A-9b			8	5	Barrow Co., Georgia
A-9c			4	3	" "
A-9d			3	2-3	" "
A-10a	80.9	11.5	6	4-5	" "
A-10b			3	3	" "
A-10c			15-18	15	Jackson Co., Georgia
A-10d			10	10-12	" "
A-10e			10	8	" "
B-1a	96.6	37.0	8	10	White Co., Georgia
B-1b			8	7	" "
B-1c			4	4	" "
B-2a	107.7	15.0	6	2	" "
B-2b			6	6	" "
B-2c			6	12	" "
B-3a	39.5	4.0	3	2	" "
B-3b			12	25	Habersham Co., Georgia
B-3c			18	20	" "
B-3d			8	8	" "
B-4a	336.8	20.2	10	20	Banks Co., Georgia
B-4b			5	2	" "
B-4c			18	10	" "

TABLE 1 (cont.)

Sample No.	-100 mesh wt. (gms)	Heavy mineral conc. wt. (gms)	Approx. stream depth (inches)	Approx. stream width (feet)	Location	
B-5a	87.7	4.1	10	20	Banks Co., Georgia	
B-5b			8	15	"	"
B-5c			10	20	"	"
C-1a	257.8	15.2	8	10	Swain Co., North Carolina	
C-1b			14	25	"	"
C-1c			5	6	"	"
C-2a	74.4	26.2	8	15	"	"
C-2b			8	20	Macon Co, North Carolina	
C-3a	136.4	52.9	4	6	"	"
C-3b			6	5	"	"
C-3c			8	10	"	"
C-4a	605.1	414.8 (75 g.)	12	30	"	"
C-4b			4	6	"	"
C-4c			6	10	"	"
C-5a	77.0	5.0	10	12	"	"
C-5b			8	15	"	"
C-5c			6	12	"	"
C-6a	65.2	4.2	4	6	Rabun Co., Georgia	
C-6b			8	10	"	"
C-6c			6	15	"	"
C-6d			8	10	"	"

TABLE 1 (cont.)

Sample No.	-100 mesh wt. (gms)	Heavy mineral conc. wt. (gms)	Approx. stream depth (inches)	Approx. stream width (feet)	Location
C-7a	189.7	29.1	6	8	Oconee Co., South Carolina
C-7b			6	6	" "
C-7c			24	35	" "
D-1a	219.3	33.2	8	12	Abbeville Co., South Carolina
D-1b			8	8	" "
D-2a	140.7	8.6	10	10	" "
D-2b			6	3	" "
D-2c			10	20	" "
D-3a	338.8	9.9	8	10	Anderson Co., South Carolina
D-3b			10	12	" "
D-3c			8	10	" "
D-4a	245.4	20.8	8	10	" "
D-4b			6	12	" "
D-4c			5	8	" "
E-1a	118.4	35.9	6	12	Pickens Co., South Carolina
E-1b			8	4	" "
E-1c			6	4	" "
E-2a	136.7	8.3	6	12	" "
E-2b			4	6	" "
E-2c			4	12	" "
E-2d			4	10	" "
E-3a	66.4	12.1	6	20	" "
E-3b			4	6	" "
E-3c			4	6	Greenville Co., South Carolina

TABLE 1 (cont.)

Sample No.	-100 mesh wt. (gms)	Heavy mineral conc. wt. (gms)	Approx. stream depth (inches)	Approx. stream width (feet)	Location	
E-4a	63.1	24.6	4	3	Greenville Co., South Carolina	
E-4b			6	10	"	"
E-4c			6	8	"	"
E-5a	130.6	13.2	8	15	"	"
E-5b			18	30	"	"
E-6a	110.3	7.4	4	8	"	"
E-6b			5	10	"	"
E-6c			5	20	Laurens Co., South Carolina	
E-7a	33.0	2.5	4	20	"	"
E-7b			8	30	"	"
E-8a	96.2	5.1	6	15	"	"
E-8b			5	8	"	"
F-1a	78.5	6.3	10	8	Cleveland Co., North Carolina	
F-1b			8	10	"	"
F-1c			8	12	"	"
F-1d			8	8	"	"
F-2a	57.0	4.5	6	8	"	"
F-2b			8	15	"	"
F-2c			12	30	"	"

TABLE 1. (cont.)

Sample No.	-100 mesh wt. (gms)	Heavy mineral conc. wt. (gms)	Approx. stream depth (inches)	Approx. stream width (feet)	Location	
F-3a	88.0	12.1	10	20	Cleveland Co., North Carolina	
F-3b			4	4	"	"
F-3c			4	6	"	"
F-4a	146.2	18.6	5	6	Rutherford Co., North Carolina	
F-4b			3	4	"	"
F-4c			6	10	"	"
F-5a	92.0	22.4	8	12	"	"
F-5b			6	8	"	"
F-5c			8	12	"	"
F-6a	303.5	28.1	12	20	"	"
F-6b			12	20	"	"
G-1a	92.0	4.6	10	10	Union Co., North Carolina	
G-1b			10	10	"	"
G-2a	401.5	8.0	8	12	Chesterfield Co., South Carolina	
G-2b			10	15	"	"
G-2c			12	15	"	"
G-3a	57.0	5.1	6	3	"	"
G-3b			8	6	"	"
G-3c			4	4	"	"
G-4	53.6	1.2	10	15	"	"

TABLE 1. (cont.)

Sample No.	-100 mesh wt. (gms)	Heavy mineral conc. wt. (gms)	Approx. stream depth (inches)	Approx. stream width (feet)	Location	
G-5a	21.6	0.3	8	15	Chesterfield Co., South Carolina	
G-5b			6	15	" "	
H-1a	243.0	18.8	12	12	Calhoun Co., South Carolina	
H-1b			24	18	" "	
H-1c			3	2	" "	
H-2a	71.7	3.1	6	8	Lexington Co., South Carolina	
H-2b			10	3	" "	
H-2c			10	20	" "	
H-3a	153.2	5.5	12	20	" "	
H-3b			8	15	" "	
H-4a	77.8	5.6	12	20	" "	
H-4b			8	3	" "	
H-4c			6	3	" "	
H-5a	113.3	1.9	4	6	" "	
H-5b			6	12	" "	
H-5c			4	12	" "	
H-5d			3	4	" "	
H-6a	72.9	2.5	6	6	Saluda Co., South Carolina	
H-6b			3	3	" "	
H-6c			4	5	" "	
H-7a	104.2	4.1	4	3	" "	
H-7b			4	6	" "	

APPENDIX B

SAVANNAH RIVER LABORATORY
ANALYTICAL CHEMISTRY DIVISION

REPORT OF SCANNING ELECTRON MICROPROBE ANALYSIS

SAMPLE: Sediment Particles from Traverses A through H

ACD LAB NUMBER: 80-0863 through 0870

DATE: 2/12/80

SUBMITTER: V. Price

LOCATION: 773A PHONE: 3361

PURPOSE OF ANALYSIS: Determine compositions of zircon and monazite particles collected in traverses across regions in Georgia, North Carolina and South Carolina showing high concentrations of thorium as determined by neutron activation.

METHOD(S) OF ANALYSIS: Samples were collected and prepared by Jerry Owen of the University of Georgia. Stream sediments collected along eight traverses were composited, screened to separate particles less than 100 mesh, panned to separate dense particles, and separated into three fractions (high, medium and low) corresponding to high, medium and low current settings in a magnetic separator. The three fractions from each sample were mounted in different areas of a one-inch diameter mount, polished and coated with carbon for SEMQ analysis.

Preliminary analyses showed that zircon was in the high fraction and monazite was in the medium fraction. Ten particles each in the high and medium fractions were selected for automated analysis. Each particle was tested for the presence of zirconium and phosphorus and those showing positive indications were analyzed. A 14-element general mineral analysis (MINRL) was used for the high fractions and a 15-element special analysis (MONAZ) was used for the medium fractions. MINRL used pure oxides and NBS glass standards in addition to a mixed rare-earth oxide REOXA prepared at SRL containing equal weight percentages of La_2O_3 , Ce_2O_3 , Sc_2O_3 , Y_2O_3 and Er_2O_3 . MONAZ used another mixed rare-earth oxide REOXB prepared at SRL containing equal weight percentages of Pr_2O_3 , Sm_2O_3 , Nd_2O_3 , Eu_2O_3 , Gd_2O_3 and Dy_2O_3 .

RESULTS OF ANALYSIS: Table II summarized the results of the analysis of zircons in the high fractions in NURE sediment particles. Table III summarizes similar results for monazite in the medium fractions. The results of analyses at several points within monazite particles are given in Table IV. The compositions of monazite containing low ($<0.2\%$) and high ($>1.5\%$) concentrations of UO_2 are compared in Table V.

CONCLUSIONS: The highest concentrations of ThO_2 and UO_2 in zircon were 0.3% for each. ThO_2 and UO_2 exceeded 0.1% in 7.3% and 14.6% of the zircon particles, respectively. The percentages of zircons in the high fractions varied from 0 to 100% . It may be possible to correlate these percentages and compositions with the geology of the sampled area.

The percentages of monazite particles in the medium fractions varied from 0 to 100% . UO_2 exceed 1.0% in 14.5% of the monazite particles. UO_2 concentrations greater than 1.5% correlate with increased Sm_2O_3 , Gd_2O_3 , Dy_2O_3 , Y_2O_3 and P_2O_5 concentrations and decreased La_2O_3 and Ce_2O_3 concentrations. La_2O_3 , Ce_2O_3 and Nd_2O_3 concentrations can vary about 5% within a single monazite particle

W C Mosley
W. C. Mosley

7-8-80
DATE

TABLE I

SEMQ Analysis Schemes Used To
Analyze NURE Sediment Particles

MINRL (for zircon)			MONAZ (for monazite)		
<u>Element</u>	<u>Line</u>	<u>Standard</u>	<u>Element</u>	<u>Line</u>	<u>Standard</u>
Ca	K α	NBS SRM 412	Ca	K α	Apatite
La	L α	REOXA	La	L α	REOXA
Ce	L α	REOXA	Ce	L α	REOXA
Fe	K α	NBS SRM 412	Pr	L β	REOXB
Er	L α	REOXA	Nd	L β	REOXB
Hf	L α	ZrO ₂	Sm	L β	REOXB
Y	L α	REOXA	Eu	L β	REOXB
Th	M α	ThO ₂	Gd	L β	REOXB
U	M α	UO ₂	Er	L α	REOXA
P	K α	NBS SRM 496	Dy	L β	REOXB
Zr	L α	ZrO ₂	Y	L α	REOXA
Mg	K α	NBS SRM 412	Th	M α	ThO ₂
Al	K α	NBS SRM 412	U	M α	UO ₂
Si	K α	NBS SRM 412	P	K α	Apatite
			F	K α	Apatite

TABLE II

SEMQ Analysis of Zircon in High Fractions
of NURE Sediment Particles

<u>Traverse</u>	<u>Sample Number</u>	<u>Number of Particles</u>	<u>Number of Zircons</u>	<u>Number of Zircons with ThO₂ >0.1%</u>	<u>Number of Zircons with UO₂ >0.1%</u>
A	1	14	1	0	0
A	2	10	0	0	0
A	3	10	9	2	3
A	4	10	4	1	1
A	5	10	2	0	1
A	6	10	6	0	0
A	7	10	5	0	0
A	8	10	8	0	2
A	9	10	3	0	0
A	10	10	2	1	1
B	1	10	2	0	1
B	2	10	7	0	1
B	3	10	8	0	0
B	4	10	1	0	0
B	5	10	3	0	1
C	1	10	5	0	0
C	2	10	0	0	0
C	3	10	0	0	0
C	4	10	2	0	0
C	5	10	7	0	1
C	6	10	4	0	0
C	7	10	10	0	1
D	1	11	10	3	1
D	2	10	3	0	0
D	3	10	1	0	0
D	4	10	9	1	2

TABLE II (continued)

<u>Traverse</u>	<u>Sample Number</u>	<u>Number of Particles</u>	<u>Number of Zircons</u>	<u>Number of Zircons with ThO₂ >0.1%</u>	<u>Number of Zircons with UO₂ >0.1%</u>
E	1	10	9	1	1
E	2	10	4	0	1
E	3	10	3	0	0
E	4	10	6	0	1
E	5	10	5	0	0
E	6	10	3	0	2
E	7	10	3	0	2
E	8	10	3	1	1
F	1	10	0	0	0
F	2	10	0	0	0
F	3	10	0	0	0
F	4	10	0	0	0
F	5	10	5	2	1
F	6	10	1	0	0
G	1	10	1	0	0
G	2-1	10	3	1	1
G	2-2	10	4	0	1
G	3-1	11	8	0	1
G	3-2	10	7	1	0
G	4	10	0	0	0
G	5	11	0	0	0
G	5-2	10	0	0	0
H	1	10	4	0	1
H	2	10	7	0	0
H	3	10	5	0	1
H	4	10	7	0	0
H	5	10	1	1	0
H	6	10	5	0	0
H	7	10	1	0	0

TABLE III

SEMQ Analysis of Monazite in Medium
Fraction of NURE Sediment Particles

<u>Traverse</u>	<u>Sample Number</u>	<u>Number of Particles</u>	<u>Number of Monazite Particles</u>	<u>Number of Monazite Particles with $UO_2 > 1.0\%$</u>
A	1	10	0	0
A	2	10	0	0
A	3	10	6	0
A	4	10	1	0
A	5	10	0	0
A	6	10	10	0
A	7	10	10	0
A	8	10	10	0
A	9	10	0	0
A	10	10	0	0
B	1	10	1	0
B	2	10	10	0
B	3	10	7	1
B	4	10	0	0
B	5	10	0	0
B	2R	10	10	0
C	1	12	0	0
C	2	10	6	1
C	3	10	1	0
C	4	10	0	0
C	5	10	5	0
C	6	10	3	0
C	7	10	0	0
D	1	10	0	0
D	2	10	0	0
D	3	10	6	1
D	4	10	5	0

TABLE III (continued)

<u>Traverse</u>	<u>Sample Number</u>	<u>Number of Particles</u>	<u>Number of Monazite Particles</u>	<u>Number of Monazite Particles with $UO_2 > 1.0\%$</u>
E	1	10	0	0
E	2	10	0	0
E	3	10	9	0
E	4	10	9	3
E	5	10	0	0
E	6	10	1	0
E	7	10	4	0
E	8	10	1	0
F	1	10	0	0
F	2	10	6	2
F	3	10	0	0
F	4	10	6	2
F	5	10	1	1
F	6	10	1	0
G	1	10	0	0
G	2-1	10	1	0
G	2-2	10	1	1
G	3-1	10	7	0
G	3-2	11	7	6
G	4	10	1	0
G	5-1	10	0	0
G	5-2	10	0	0
G	3-2R	10	7	3
H	1	11	3	1
H	2	10	2	2
H	3	10	1	0
H	4	10	2	0
H	5	10	4	0
H	6	10	0	0
H	7	10	1	0

R = Rerun

TABLE IV

SEM-Q Analysis of Monazite Particles in
NURE Sediment B2-Medium

Component	Particle #2		Particle #3			Particle #7		
	Point 1	Point 2	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3
CaO	0.9	0.8	1.4	1.5	1.4	1.1	1.0	0.9
La ₂ O ₃	14.8	15.6	12.8	12.9	13.5	15.3	15.1	14.5
Ce ₂ O ₃	29.9	30.7	27.3	27.6	27.2	28.7	29.6	29.9
Pr ₂ O ₃	2.7	2.6	2.7	2.7	2.5	2.8	2.6	2.8
Nd ₂ O ₃	11.6	10.9	10.3	10.5	10.3	10.6	10.6	10.9
Sm ₂ O ₃	1.8	1.7	2.2	2.1	2.4	1.4	1.4	1.9
Eu ₂ O ₃	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.2
Gd ₂ O ₃	1.7	1.5	2.3	2.1	2.0	1.4	1.6	1.6
Er ₂ O ₃	0.2	0.2	0.3	0.1	0.4	0.1	0.2	0.2
Dy ₂ O ₃	0.6	0.6	0.7	0.7	0.7	0.7	0.6	0.6
Y ₂ O ₃	1.4	1.5	2.0	2.3	2.0	1.8	1.8	1.9
ThO ₂	4.3	3.9	7.5	7.4	7.4	5.8	5.0	4.6
UO ₂	0.4	0.6	0.5	0.5	0.5	0.7	0.7	0.7
P ₂ O ₅	29.0	28.8	29.2	29.1	29.2	28.8	29.1	29.0
F	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4

TABLE V

Compositions of Monazite Particles with
Low (<0.2%) and High (>1.5%) UO_2

<u>Component</u>	<u>11 Particles with UO_2 <0.2%</u>		<u>11 Particles with UO_2 >1.5%</u>	
	<u>Avg</u>	<u>1σ</u>	<u>Avg</u>	<u>1σ</u>
CaO	1.2	1.0	1.2	0.2
La_2O_3	16.7	1.7	13.8	1.3
Ce_2O_3	32.1	1.8	28.5	1.3
Pr_2O_3	3.0	0.2	2.8	0.2
Nd_2O_3	10.9	1.2	11.2	0.6
Sm_2O_3	1.4	0.4	2.1	0.3
Eu_2O_3	0	0	0	0
Gd_2O_3	0.8	0.5	1.8	0.4
Er_2O_3	0.1	0.1	0.2	0.1
Dy_2O_3	0.1	0.1	0.7	0.2
Y_2O_3	0.7	0.4	2.1	0.6
ThO_2	5.0	2.1	4.8	1.5
UO_2	0.2	0.1	1.7	0.3
P_2O_5	27.9	0.6	29.0	0.3
F	0.4	0.1	0.3	0.1

APPENDIX C

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Report of analysis of zircons from the Southeastern Piedmont:
Samples E-3, E-7, and G-2

Analysis Methods

The three samples were recieved in the form of grains mounted in 1" dia. plastic discs, ground, polished, and carbon coated. There were three sections in each mount; the zircon was found in only one of them (presumably the lowest magnetic susceptibility portion of the sample).

The analyses were made with a Materials Analysis Co. Model 400S electron microprobe fitted with a Canberra Si(Li) X-ray energy detection system with model 8100 multichannel analyser. The programing for data reduction on this system was written by J. Stormer using the algorithms in Myklebust, et al. (Nat. Bur. Stand. Tech. Note 1106; 1979). This system has been in routine use for several years and has been proven to give results for major elements comparable to spectrometer data, with the additional advantage of simultaneous data collection on all elements. The electron beam was operated at 15 KeV. to give a sample current on the zircon of 22 nanoamperes. The counting time intervals used were 100 and 50 "live time" seconds

Quantitative analyses were made for the following elements (with respective x-ray line used): Si(K_α), Zr(L_α), Fe(K_α), Hf(M_α). Quantitative analysis for U and Th was attempted but in no case were the results significantly above background with an estimated detection limit of 0.3%. The Hf M line was used rather than the somewhat more intense L line because the L line at 1.644 KeV. is very close to Si(K) at 1.739 and on a very high and sloping region of the background. The Hf(M) at 7.898 KeV. is free of interferences and in a region of much lower and nearly flat background. The standards used were: Standard zircon (Si,Zr), Synthetic Fayalite (Fe), and Synthetic Hf,U,Th,Li borate Glass. Bence-Albee corrections were calculated, but in all cases except Hf the correction was less than 1%. For Hf a correction factor of 0.91 (zircon/standard) was applied. Si was corrected for overlap of the Hf(L_α) peak.

The CRT display of the spectra collected for digital analysis was also scanned visually for other elements. Previous experience indicates that for elements above atomic no. 12 amounts greater than 0.5% (as oxides) should be detectable. No other elements were noted.

The results of the analyses have been coded on computer cards as requested. The cards and a print-out accompany this report. This tabulation includes sample number, weight percent SiO_2 , ZrO_2 , FeO , HfO_2 , Total, and cation proportions (relative to 4 oxygen in the formula ZrSiO_4) Si, Zr, Fe, and Hf.

Results

There did not appear to be anything unusual in the analyses of these zircons. In particular, the HfO_2 contents were between 0.4 and 1.8% and Hf/Zr ratios .004 to .017 are well within the range of common zircons. None of the grains analysed were unusually rich in Hf, U, Th, Y, or P. Although there is some variation between grains, a cursory scan of the analyses did not indicate any significant difference between the samples. Further statistical treatment of the data might well show more subtle differences, however.

In sample E-3 grain 1, sample E-7 grains 1 and 2, and Sample G-2 grain 13 were selected for detailed analysis of possible zonation within grains. a polaroid photograph was taken of each of these grains and the analysis region located on the photographs. No recognizable pattern of zoning such as would be expected from weathering alteration was observed. There is a fine scale concentric banding which is observed especially in the variation of intensity of the blue cathodoluminescence. This is a result of magmatic (or metamorphic) growth zoning of trace elements (probably rare earth elements in this case). Concentrations far below detection limits are sufficient to produce this effect, and it is not particularly unusual.

The SiO_2 contents seem to be systematically low by a small amount. This discrepancy appeared in all samples even though each of the samples was run separately and on two different days. It is unlikely to be a problem with standardization or matrix corrections since a nearly identical zircon was used for the standard and ZrO_2 seems to be within expected limits. There is some possibility that there is $\text{SiO}_4 \rightleftharpoons (\text{OH})_4$ substitution. (see Deer et al., 1967, An Introduction to the Rock Forming Minerals, p. 15). (OH) cannot be detected by microprobe techniques. Other possible substitutions such as YPO_4 should have been detected. An alternative might be that the correction for overlap of the Hf(L_{α}) peak was slightly overestimated for the unknowns. Though, it seems unlikely that this small correction could have such a large effect.

J. C. Stormer, Jr.

"This report represents the work of the author. It carries no official endorsement by the University of Georgia."

TABLE 1: MONAZITE ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	PR2O3	ND2O3	SM2O3	EU2O3	GD2O3	ER2O3	DY2O3	Y2O3	THO2	UO2	P2O5	F	TOTAL
A03	01	0.65	14.74	28.71	2.37	9.67	1.37	0.00	0.01	0.00	0.36	1.47	12.58	0.56	26.84	0.67	90.70
A03	02	0.63	15.91	30.89	2.39	9.66	1.55	0.00	0.92	0.00	0.20	1.81	6.90	0.49	28.26	0.40	95.78
A03	03	0.37	15.76	32.03	2.79	10.67	1.27	0.00	0.45	0.00	0.38	1.12	6.02	0.54	28.03	0.57	95.15
A03	04	0.48	13.39	26.92	2.33	9.77	1.77	0.23	1.09	0.04	0.02	1.10	16.68	0.97	24.67	0.54	94.54
A03	05	0.45	16.26	30.74	3.11	10.51	1.36	0.00	0.42	0.00	0.29	0.94	7.51	0.43	27.46	0.51	88.67
A03	06	0.33	15.79	30.67	2.86	10.03	1.23	0.00	0.66	0.06	0.30	0.97	9.43	0.35	26.97	0.33	95.83
A04	01	1.42	13.97	28.65	3.10	11.55	2.27	0.32	1.55	0.35	0.61	2.26	4.05	0.31	29.04	0.54	96.35
A06	01	0.52	14.78	29.93	2.89	12.26	1.90	0.15	1.81	0.17	0.57	2.29	2.75	0.66	28.93	0.40	109.75
A06	02	0.79	17.34	31.65	2.63	9.45	1.10	0.00	0.72	0.08	0.24	1.23	5.57	0.42	28.27	0.51	110.61
A06	03	0.76	14.02	28.71	3.03	11.48	1.93	0.10	1.79	0.26	0.81	2.87	4.16	0.37	29.33	0.39	111.97
A06	04	0.45	15.02	30.25	3.08	12.83	1.98	0.00	0.76	0.00	0.43	1.01	5.32	0.23	28.18	0.47	106.66
A06	05	1.08	16.05	30.15	2.51	10.57	1.58	0.06	1.23	0.12	0.61	1.97	4.41	0.44	28.81	0.41	110.59
A06	06	0.92	18.18	30.88	2.68	9.24	0.80	0.00	0.54	0.04	0.00	0.35	7.80	0.18	27.90	0.47	112.68
A06	07	1.13	14.41	29.08	2.52	11.07	1.77	0.07	1.40	0.17	0.51	2.02	6.08	0.29	29.22	0.27	112.73
A06	08	1.52	12.24	25.23	2.52	10.47	1.95	0.02	1.72	0.00	0.68	2.39	12.47	0.88	27.53	0.38	106.91
A06	09	1.49	13.44	28.63	2.64	10.81	2.07	0.36	1.79	0.29	0.77	2.91	4.49	0.57	29.26	0.48	111.71
A06	10	0.78	14.85	28.97	2.79	11.72	1.70	0.05	1.55	0.25	0.51	2.39	4.19	0.66	29.19	0.40	110.94
A07	01	1.16	14.35	29.30	2.79	11.55	2.10	0.14	1.64	0.27	0.57	2.58	3.39	0.39	29.30	0.46	113.14
A07	02	1.04	14.29	29.04	2.86	11.40	1.81	0.02	1.25	0.25	0.65	2.57	4.24	0.52	29.54	0.52	112.05
A07	03	0.83	13.77	28.50	2.91	11.42	1.94	0.00	1.70	0.27	0.73	3.02	4.43	0.80	29.24	0.44	110.69
A07	04	0.75	15.46	29.78	2.89	11.01	1.68	0.08	1.29	0.17	0.36	2.13	4.54	0.62	28.84	0.39	112.98
A07	05	0.64	14.27	30.22	2.72	11.53	1.71	0.15	1.68	0.21	0.54	2.32	3.65	0.56	29.30	0.49	111.64
A07	06	0.79	14.28	29.08	2.76	11.67	2.00	0.02	1.49	0.28	0.57	2.04	5.14	0.64	28.88	0.37	112.26
A07	07	0.97	14.82	29.93	2.96	11.48	1.93	0.08	1.52	0.06	0.32	0.84	4.83	0.74	29.02	0.50	112.85
A07	08	0.83	14.54	29.17	2.78	11.38	1.92	0.00	1.60	0.23	0.61	2.16	4.58	0.63	29.10	0.45	112.22
A07	09	0.88	13.75	28.28	2.58	11.68	2.07	0.07	2.02	0.37	0.88	3.00	3.89	0.71	29.44	0.40	98.28
A07	10	0.75	13.87	29.87	2.94	11.91	2.15	0.00	1.55	0.11	0.55	1.86	4.10	0.49	29.35	0.51	98.59
A08	01	0.67	15.14	30.46	2.67	11.66	1.97	0.17	1.53	0.24	0.43	1.70	3.55	0.40	29.04	0.39	110.51
A08	02	0.68	14.53	28.93	3.33	11.59	1.84	0.07	1.58	0.38	0.55	2.11	4.20	0.62	28.90	0.70	111.94
A08	03	0.78	14.07	28.96	2.77	12.14	2.21	0.00	1.72	0.26	0.66	2.13	4.08	0.83	28.95	0.43	110.59
A08	04	1.13	13.56	28.32	2.91	11.08	2.17	0.06	1.51	0.12	0.77	2.28	5.85	0.74	29.10	0.41	107.50
A08	05	0.85	13.61	28.25	2.67	11.59	2.17	0.11	1.80	0.33	0.73	2.41	5.35	0.88	28.76	0.51	109.71
A08	06	0.68	14.73	28.61	2.85	11.61	2.08	0.09	1.56	0.24	0.67	2.50	4.04	0.71	29.25	0.38	108.72
A08	07	0.80	15.16	28.97	2.55	11.11	1.91	0.05	1.39	0.22	0.52	1.89	5.35	0.58	29.04	0.46	109.44
A08	08	0.51	16.26	31.48	3.03	11.07	1.42	0.17	1.40	0.42	0.63	2.19	1.87	0.53	28.62	0.39	106.94
A08	09	0.73	17.49	32.21	2.57	9.84	1.22	0.08	0.66	0.17	0.19	1.03	4.46	0.41	28.44	0.49	111.28
A08	10	0.77	14.73	29.06	3.17	11.42	1.68	0.00	1.44	0.34	0.54	2.04	4.37	0.61	29.28	0.54	108.84
B01	01	0.97	14.26	28.79	2.85	12.27	2.20	0.21	2.29	0.16	0.51	1.64	4.29	0.85	28.31	0.42	101.91
B03	01	0.80	15.35	31.67	3.00	11.54	1.74	0.03	1.11	0.02	0.03	0.46	4.07	0.71	29.06	0.42	106.71
B03	02	0.31	13.29	31.52	3.09	12.14	2.10	0.00	1.08	0.01	0.00	0.24	8.54	0.24	27.02	0.43	105.87
B03	03	0.65	15.57	33.36	3.02	9.05	2.23	0.00	0.92	0.00	0.70	1.26	2.88	1.20	28.61	0.57	104.90
B03	04	0.70	14.44	30.24	3.17	12.75	1.97	0.00	0.73	0.00	0.71	1.27	3.53	0.58	29.58	0.32	103.68
B03	05	0.72	13.48	31.89	2.66	11.17	1.98	0.00	1.64	0.00	0.84	1.41	3.93	0.50	29.32	0.47	103.86
B03	06	1.11	13.04	30.43	2.66	11.38	1.93	0.06	1.67	0.00	0.75	1.22	5.55	0.72	29.03	0.45	106.02
B03	07	0.95	14.55	30.66	2.96	12.15	2.23	0.00	1.46	0.07	0.06	0.40	4.68	0.64	28.72	0.47	108.25
C02	01	0.83	14.92	31.24	3.01	12.26	1.88	0.00	1.07	0.08	0.00	0.26	4.74	0.48	28.67	0.55	107.39
C02	02	0.84	14.76	29.63	3.03	12.00	2.38	0.00	2.08	0.05	0.42	0.78	3.31	1.08	29.29	0.37	105.78
C02	03	0.68	16.18	31.10	2.93	11.71	1.55	0.00	0.72	0.02	0.04	0.47	5.69	0.32	28.14	0.44	108.08
C02	04	0.57	15.71	31.36	3.13	12.56	2.20	0.01	1.19	0.06	0.06	0.16	2.78	0.69	29.07	0.44	107.93
C02	05	0.89	14.46	30.39	2.95	12.47	1.97	0.00	1.52	0.13	0.22	0.55	4.60	0.49	28.97	0.39	108.16
C02	06	0.77	15.80	30.89	2.69	11.33	1.62	0.00	1.42	0.11	0.42	1.17	3.87	0.56	28.88	0.47	105.41
C03	01	0.81	15.22	31.09	3.19	12.27	1.88	0.00	1.24	0.07	0.17	0.41	4.15	0.43	28.68	0.39	104.21
C05	01	1.13	16.19	31.68	2.78	11.02	1.31	0.00	0.69	0.14	0.12	0.67	5.17	0.16	28.42	0.51	112.48
C05	02	1.12	15.27	29.43	2.60	10.30	1.61	0.23	1.34	0.15	0.64	2.30	4.65	0.58	29.38	0.39	113.02

TABLE 1: MONAZITE ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	PR2O3	ND2O3	SM2O3	EU2O3	GD2O3	ER2O3	DY2O3	Y2O3	THO2	UO2	P2O5	F	TOTAL
C05	03	0.95	15.78	29.87	2.91	10.47	1.58	0.00	1.06	0.16	0.42	1.29	6.32	0.30	28.38	0.50	112.96
C05	04	1.04	15.89	30.47	2.70	10.91	1.58	0.13	1.32	0.12	0.49	1.72	3.75	0.44	28.96	0.48	112.40
C05	05	1.39	13.74	27.75	2.62	10.94	2.10	0.19	1.78	0.21	0.74	2.61	5.63	0.60	29.33	0.37	111.95
C06	01	0.91	14.66	29.64	2.86	10.60	1.71	0.15	1.30	0.30	0.50	2.84	4.62	0.62	28.84	0.45	110.86
C06	02	0.73	14.97	29.86	2.83	11.04	1.97	0.28	1.65	0.12	0.57	1.59	4.08	0.55	29.37	0.37	111.92
C06	03	0.65	15.32	30.52	3.02	11.51	1.65	0.06	1.16	0.33	0.35	2.01	3.70	0.47	28.73	0.53	102.66
D03	01	0.61	15.56	31.77	2.91	11.36	1.49	0.00	1.07	0.09	0.21	0.61	5.26	0.21	28.44	0.41	108.13
D03	02	1.18	14.26	28.09	2.65	10.42	1.71	0.06	1.47	0.30	0.63	2.29	5.99	0.96	29.54	0.44	109.09
D03	04	0.80	15.62	30.45	2.88	11.27	1.60	0.00	1.11	0.15	0.35	1.13	4.78	0.36	29.03	0.48	109.89
D03	05	0.84	14.89	29.72	2.89	11.23	1.56	0.10	1.27	0.21	0.48	1.75	4.91	0.60	29.12	0.43	108.87
D03	06	0.75	15.08	30.78	2.78	11.62	1.82	0.00	1.23	0.00	0.34	0.87	5.12	0.34	28.85	0.42	108.63
D03	10	1.00	14.86	29.59	2.73	11.01	1.48	0.00	1.14	0.20	0.43	1.76	5.52	0.70	29.18	0.40	108.49
D04	06	1.10	14.65	29.12	2.66	11.45	1.87	0.21	1.37	0.21	0.58	2.05	4.37	0.65	29.25	0.45	107.76
D04	07	0.36	14.64	30.50	2.99	12.16	2.22	0.18	1.71	0.14	0.51	0.96	4.44	0.17	28.57	0.46	108.31
D04	08	1.05	14.26	29.54	2.78	12.18	1.96	0.11	1.73	0.16	0.74	1.95	2.79	0.77	29.46	0.52	108.48
D04	09	1.46	14.26	29.29	2.86	11.12	1.99	0.01	1.54	0.19	0.48	1.68	4.52	0.70	29.37	0.52	108.02
D04	10	1.45	13.69	27.38	2.79	11.29	1.69	0.02	1.32	0.18	0.48	1.12	9.15	0.35	28.64	0.45	108.69
E03	01	0.98	14.52	29.71	2.73	10.79	1.59	0.00	1.08	0.16	0.27	1.08	7.91	0.35	28.38	0.47	109.60
E03	02	0.46	14.48	30.94	2.97	11.70	1.93	0.00	1.49	0.13	0.46	1.78	4.69	0.34	28.14	0.47	105.49
E03	03	0.46	14.81	31.22	2.96	11.68	1.79	0.00	1.28	0.21	0.48	1.64	3.51	0.36	29.16	0.41	109.76
E03	04	1.00	14.77	29.57	2.78	11.89	1.56	0.00	1.35	0.03	0.35	1.06	5.80	0.40	28.87	0.56	108.54
E03	05	0.70	14.11	29.96	2.79	11.84	2.11	0.00	1.46	0.23	0.57	1.26	5.34	0.48	28.55	0.59	110.01
E03	06	0.68	14.98	30.29	3.18	11.82	1.80	0.00	1.15	0.21	0.33	1.24	5.39	0.25	28.17	0.50	107.49
E03	08	0.75	17.35	31.75	2.78	10.64	1.36	0.00	0.48	0.01	0.03	0.28	5.64	0.19	28.16	0.57	105.24
E03	09	0.57	14.82	30.52	3.18	11.92	1.87	0.00	1.51	0.00	0.32	0.66	5.64	0.33	28.15	0.51	109.34
E03	10	1.18	13.32	27.81	2.72	11.72	2.04	0.02	1.56	0.14	0.57	1.40	7.40	0.91	28.77	0.43	108.08
E04	02	0.72	15.67	31.85	3.09	11.53	1.43	0.00	1.04	0.05	0.23	0.38	4.40	0.50	28.63	0.49	109.90
E04	03	0.83	15.27	29.28	3.00	11.72	2.07	0.00	1.66	0.16	0.58	1.45	3.65	0.79	29.10	0.44	103.66
E04	05	0.68	15.95	32.74	2.77	9.92	1.19	0.00	0.76	0.25	0.59	1.51	3.20	0.77	29.13	0.52	108.62
E04	06	0.55	15.52	32.77	3.02	11.48	0.56	0.00	0.00	0.00	0.35	0.94	5.67	0.23	28.45	0.47	92.67
E04	08	1.03	14.71	29.66	2.71	10.21	1.55	0.00	1.28	0.10	0.62	1.48	6.23	1.11	28.80	0.51	109.38
E04	09	0.95	13.45	28.07	2.60	10.83	2.04	0.24	2.00	0.36	0.99	2.65	3.89	1.72	29.75	0.45	108.29
E04	10	1.13	13.90	28.65	2.69	10.28	1.70	0.00	0.70	0.00	0.57	2.03	7.59	1.53	28.72	0.52	105.72
E06	08	0.77	15.46	30.93	2.86	11.51	1.63	0.00	1.08	0.06	0.19	0.70	5.28	0.64	28.28	0.61	108.60
E07	07	0.95	17.23	30.33	2.63	9.37	1.36	0.00	0.85	0.00	0.33	1.16	6.13	0.46	28.69	0.50	109.05
E07	08	1.33	14.01	28.82	2.84	10.33	1.85	0.00	1.46	0.20	0.45	1.40	7.26	0.71	28.88	0.46	108.63
E07	09	1.15	13.61	29.17	2.87	10.97	1.98	0.00	1.52	0.18	0.35	1.11	7.62	0.58	28.44	0.44	105.89
E07	10	0.99	17.04	34.55	2.95	10.59	0.88	0.00	0.32	0.03	0.07	0.33	4.27	0.25	27.22	0.53	105.88
E08	01	1.00	14.36	30.05	3.00	11.30	1.15	0.00	0.00	0.00	0.60	2.16	6.78	0.64	28.72	0.25	88.05
F01	01	0.98	13.63	30.46	3.05	13.70	2.84	0.00	1.66	0.12	0.13	0.30	4.50	0.41	27.88	0.35	102.55
F01	02	0.92	13.87	30.87	3.27	13.40	2.58	0.00	1.59	0.06	0.10	0.28	4.43	0.42	27.77	0.45	100.29
F01	03	0.90	13.73	30.53	3.11	13.39	2.79	0.00	1.81	0.15	0.04	0.32	4.53	0.39	27.94	0.36	101.86
F02	01	1.02	15.32	29.80	2.84	11.35	2.03	0.00	1.44	0.11	0.31	0.95	5.35	0.61	28.37	0.49	106.08
F02	02	0.80	15.52	30.67	2.92	10.99	1.73	0.00	0.76	0.00	0.01	0.28	8.46	0.47	26.86	0.53	105.02
F02	03	0.63	14.88	29.69	2.92	11.10	1.98	0.00	1.69	0.33	0.82	2.70	2.96	1.12	28.86	0.32	102.88
F02	04	1.21	14.21	28.65	2.89	10.97	2.22	0.00	1.52	0.00	0.46	1.24	6.23	1.41	28.50	0.50	104.52
F02	05	1.05	14.75	29.87	2.80	11.72	2.19	0.00	1.53	0.03	0.45	0.64	5.36	0.94	28.19	0.48	105.24
F02	06	0.99	14.31	30.00	2.91	11.35	2.09	0.00	0.83	0.00	0.14	0.80	7.86	0.74	27.51	0.46	104.67
F02	07	0.88	17.33	30.10	2.79	10.93	1.20	0.00	0.68	0.14	0.00	0.41	7.45	0.24	27.47	0.38	105.99
F02	08	0.49	17.13	31.82	2.96	11.81	1.63	0.02	0.65	0.04	0.00	0.79	3.35	0.26	28.72	0.33	104.41
F02	09	0.97	14.10	29.44	3.04	11.12	1.87	0.00	1.00	0.00	0.60	1.27	6.93	1.12	28.15	0.37	96.04
F02	10	1.04	13.87	28.53	2.60	10.54	1.76	0.00	1.38	0.02	0.60	2.27	7.56	0.73	28.65	0.44	101.84
F03	01	0.53	15.86	31.50	3.10	12.41	2.00	0.00	1.29	0.11	0.00	0.44	3.29	0.75	28.33	0.41	103.37
F03	02	1.11	15.63	31.94	2.76	11.12	1.54	0.00	0.00	0.00	0.00	0.25	5.03	1.35	28.82	0.45	98.84

TABLE 1: MONAZITE ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	PR2O3	ND2O3	SM2O3	EU2O3	GD2O3	ER2O3	DY2O3	Y2O3	THO2	UO2	P2O5	F	TOTAL
F03	03	0.92	14.07	27.27	2.75	11.03	2.13	0.00	2.39	0.30	0.77	2.93	4.41	1.11	29.45	0.46	103.58
F03	04	1.06	14.28	29.59	3.17	11.93	2.39	0.00	1.59	0.00	0.13	0.24	5.04	1.37	28.73	0.49	103.90
F03	05	1.21	15.92	30.49	2.94	9.86	1.53	0.00	0.22	0.00	0.68	1.63	4.23	2.39	28.41	0.48	95.00
F03	06	0.81	15.21	30.36	2.83	11.25	1.97	0.00	1.46	0.32	0.43	1.14	4.02	0.55	29.19	0.47	103.78
F03	07	1.00	14.16	28.85	2.67	11.30	2.24	0.00	1.91	0.09	0.42	1.11	6.17	0.87	28.75	0.48	102.34
F03	08	1.05	15.42	30.30	2.75	11.25	1.64	0.00	0.41	0.00	0.35	1.54	4.56	1.51	28.89	0.32	99.05
F03	09	1.10	15.59	28.87	2.76	10.34	1.70	0.00	1.27	0.15	0.51	1.82	4.94	1.37	29.28	0.30	103.54
F03	10	0.72	15.16	29.15	2.61	9.97	1.45	0.00	1.04	0.20	0.08	1.20	9.39	0.88	27.55	0.60	103.67
F03	11	0.55	19.35	31.82	2.67	8.87	0.58	0.00	0.06	0.00	0.00	0.17	8.38	0.26	26.86	0.44	103.74
F03	12	0.84	15.81	30.70	2.85	12.14	2.03	0.00	1.44	0.04	0.14	0.16	4.32	0.68	28.49	0.36	105.61
F03	13	0.88	17.92	29.96	2.48	9.65	1.16	0.00	0.59	0.20	0.00	0.41	8.88	0.25	27.20	0.42	106.14
F03	14	0.94	16.03	29.45	2.70	10.38	1.47	0.00	1.12	0.24	0.62	1.75	4.91	0.95	29.10	0.34	102.99
F03	15	0.93	13.67	27.31	2.53	10.93	2.20	0.00	2.42	0.33	1.02	2.69	4.47	1.19	29.83	0.47	103.04
F04	01	0.91	18.37	32.49	2.72	9.12	1.09	0.00	0.35	0.03	0.10	0.54	5.45	0.24	28.22	0.36	110.56
F04	02	1.10	14.46	29.31	2.69	10.75	1.90	0.00	1.47	0.27	0.51	2.31	3.98	1.72	29.28	0.25	109.81
F04	03	0.43	17.61	34.71	3.07	12.24	1.52	0.00	0.00	0.00	0.05	0.81	2.36	0.23	26.69	0.28	97.07
F04	04	1.27	14.94	30.67	2.83	11.39	1.58	0.00	0.00	0.00	0.26	0.85	6.21	0.67	28.98	0.36	100.22
F04	05	1.09	14.54	30.00	2.96	11.96	2.22	0.00	1.56	0.00	0.18	0.52	4.45	0.98	29.27	0.27	108.95
F04	06	1.07	16.22	31.77	2.63	10.75	1.22	0.00	0.17	0.00	0.28	1.09	4.00	1.45	29.05	0.29	104.50
F04	07	0.99	15.94	29.65	2.73	10.01	1.60	0.00	1.00	0.07	0.61	2.01	4.40	1.32	29.19	0.48	106.71
F04	08	0.59	17.07	32.08	2.86	11.54	1.73	0.00	0.14	0.00	0.26	0.87	3.45	0.46	28.55	0.41	97.39
F04	09	1.19	14.62	29.84	2.76	11.59	1.93	0.00	1.27	0.13	0.11	0.44	5.62	1.26	28.70	0.52	107.51
F04	10	0.97	15.12	30.58	2.83	11.36	2.07	0.00	1.08	0.00	0.29	1.05	4.22	1.14	28.87	0.42	106.58
F04	11	0.55	20.06	33.38	2.48	8.91	0.71	0.00	0.00	0.00	0.06	0.30	5.15	0.21	27.68	0.51	105.86
F04	12	0.57	18.38	32.05	2.67	9.48	1.02	0.00	0.23	0.00	0.00	0.36	7.07	0.31	27.42	0.43	106.39
F04	13	0.92	15.40	30.59	2.81	11.91	2.14	0.00	1.12	0.08	0.15	0.40	4.32	0.99	28.69	0.47	106.59
F04	14	1.56	13.66	26.68	2.58	10.34	1.88	0.00	1.31	0.05	0.35	1.77	10.44	0.74	28.23	0.42	104.19
F04	15	0.32	16.73	32.59	3.16	12.56	2.04	0.00	1.31	0.08	0.00	0.29	1.76	0.33	28.41	0.43	107.69
F04	16	1.02	14.67	29.80	2.79	11.22	2.04	0.00	1.30	0.19	0.45	1.49	4.35	1.16	29.10	0.41	107.35
F05	01	0.76	15.26	31.57	2.87	11.74	2.37	0.00	1.46	0.11	0.15	0.31	3.03	1.11	29.02	0.26	109.73
F05	02	0.80	14.26	28.26	2.90	11.46	2.25	0.07	2.08	0.42	0.64	2.94	3.24	0.97	29.28	0.42	102.66
F05	03	0.84	14.73	29.24	2.92	11.92	2.08	0.15	1.50	0.27	0.67	2.15	3.18	0.89	29.04	0.42	103.32
F05	04	0.97	15.26	29.91	2.89	11.63	2.01	0.00	1.24	0.20	0.32	0.83	4.49	1.14	28.77	0.34	103.60
F05	05	0.83	15.64	31.13	2.84	11.83	2.10	0.00	1.59	0.14	0.00	0.35	3.28	1.12	28.75	0.40	103.18
F06	01	0.52	14.70	28.73	2.87	12.95	3.04	0.17	2.68	0.27	0.83	1.97	1.70	0.47	28.91	0.20	106.65
F06	02	0.65	15.03	28.07	2.63	12.79	3.19	0.33	2.61	0.26	0.65	2.00	1.63	0.69	29.04	0.43	108.91
F06	03	1.10	16.94	30.54	2.72	10.90	1.56	0.00	1.06	0.00	0.61	2.73	2.34	0.14	28.90	0.47	104.95
F06	04	0.72	18.09	32.35	2.83	10.60	1.40	0.00	1.06	0.17	0.28	0.88	2.88	0.19	28.14	0.39	109.71
G02	01	0.96	14.77	30.68	2.88	11.42	1.79	0.00	1.29	0.02	0.02	0.55	6.27	0.35	28.73	0.28	107.35
G02	02	1.31	13.01	27.30	2.76	10.82	2.26	0.04	1.95	0.31	0.77	2.39	6.51	1.52	28.75	0.30	107.34
G03	01	1.47	14.86	29.55	2.85	10.53	1.57	0.00	0.65	0.00	0.26	0.75	8.64	0.47	28.13	0.27	104.71
G03	02	0.99	13.67	28.25	2.77	11.22	1.94	0.05	1.85	0.31	0.90	2.88	4.70	0.92	29.35	0.20	104.22
G03	03	0.50	19.31	33.15	2.65	8.76	0.66	0.00	0.22	0.12	0.00	0.18	5.97	0.50	27.51	0.49	106.65
G03	04	1.26	14.83	29.72	2.90	10.88	1.81	0.00	1.14	0.15	0.28	0.64	7.20	0.68	28.22	0.27	105.81
G03	05	0.65	18.78	32.90	2.69	9.55	0.98	0.00	0.73	0.05	0.15	0.39	5.62	0.50	26.73	0.29	100.26
G03	06	0.77	14.81	30.09	2.92	12.00	2.00	0.01	1.27	0.19	0.47	0.74	5.72	0.39	28.34	0.28	105.78
G03	07	0.53	17.91	32.57	2.78	9.38	0.96	0.00	0.33	0.12	0.02	0.26	7.20	0.30	27.32	0.30	106.34
G03	08	0.98	13.17	27.20	2.83	11.70	2.30	0.00	2.23	0.40	1.13	2.86	3.55	2.07	29.34	0.23	103.74
G03	09	0.92	14.89	30.86	3.11	12.35	2.38	0.00	1.56	0.14	0.09	0.58	3.61	1.13	28.05	0.33	103.06
G03	10	1.12	14.04	29.70	2.85	12.48	2.24	0.00	1.68	0.18	0.08	0.41	5.77	0.53	28.57	0.36	104.63
G03	11	1.19	14.49	28.06	2.79	10.92	1.90	0.04	1.63	0.32	0.58	2.66	4.53	1.24	29.39	0.27	109.96
G03	12	1.46	11.18	27.63	3.07	12.48	2.62	0.00	2.10	0.15	0.52	1.30	6.89	1.46	28.92	0.23	109.90
G03	13	1.37	13.36	28.41	2.74	11.25	1.99	0.00	1.95	0.16	0.51	1.71	5.75	1.40	29.14	0.25	109.83
G03	14	1.21	13.19	27.16	2.74	10.81	2.15	0.02	2.07	0.23	0.83	2.76	5.71	1.45	29.37	0.32	109.87

TABLE 1: MONAZITE ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	PR2O3	ND2O3	SM2O3	EU2O3	GD2O3	ER2O3	DY2O3	Y2O3	THO2	UO2	P2O5	F	TOTAL
G03	15	1.20	14.02	28.74	2.92	11.81	2.32	0.13	1.83	0.27	0.66	2.30	4.02	0.52	29.04	0.22	105.10
G03	16	0.55	17.60	33.35	3.02	9.98	1.06	0.00	0.40	0.10	0.00	0.36	5.45	0.48	27.32	0.33	106.34
G03	17	0.60	15.22	31.22	2.99	11.99	1.88	0.00	1.12	0.18	0.05	0.29	5.71	0.81	27.62	0.31	105.81
G03	18	0.96	15.28	28.94	2.71	12.12	2.39	0.00	1.75	0.02	0.43	0.85	4.87	0.63	28.76	0.28	106.97
G03	19	0.91	14.52	29.10	3.02	11.45	1.95	0.00	1.36	0.37	0.69	2.26	3.90	1.58	28.55	0.33	106.07
G03	20	1.24	13.20	28.25	2.67	11.49	2.22	0.00	1.71	0.13	0.56	1.99	5.73	1.58	28.87	0.35	104.36
G03	21	0.89	15.32	28.84	2.69	11.14	2.09	0.01	1.89	0.30	0.84	2.16	2.22	2.46	28.91	0.24	105.83
H01	02	1.03	14.13	29.70	2.88	11.52	2.04	0.00	1.45	0.14	0.25	0.62	6.89	0.57	28.48	0.31	109.85
H01	03	0.64	13.22	29.31	2.85	10.56	1.57	0.00	0.96	0.16	0.51	1.50	10.95	0.99	26.51	0.27	106.87
H01	04	0.38	18.44	35.63	3.01	10.28	0.73	0.00	0.00	0.00	0.12	0.45	2.52	0.02	28.04	0.37	98.81
H02	01	1.06	14.25	27.19	2.67	11.27	1.97	0.02	2.00	0.20	0.90	2.95	4.57	1.31	29.38	0.26	106.25
H02	02	1.20	14.49	28.56	2.70	10.46	1.74	0.00	1.50	0.28	0.65	2.35	5.96	1.04	28.82	0.24	106.74
H04	01	1.08	15.24	29.08	2.97	11.79	1.65	0.00	0.00	0.00	0.54	1.53	5.72	0.80	29.28	0.32	99.56
H04	02	0.54	15.47	30.58	2.84	12.24	1.97	0.00	1.43	0.16	0.58	1.27	3.85	0.41	28.38	0.28	107.40
H05	01	0.78	19.39	34.85	2.88	10.01	0.74	0.00	0.23	0.03	0.00	0.19	2.83	0.32	27.42	0.32	108.31
H05	02	0.58	17.05	31.34	2.57	9.17	1.02	0.00	0.92	0.30	0.27	1.51	8.32	0.36	26.32	0.27	101.39
H05	03	1.17	18.47	34.01	3.03	10.22	1.00	0.00	0.32	0.07	0.03	0.20	5.14	0.38	25.68	0.28	91.74
H05	04	0.81	17.83	33.53	3.13	11.19	0.86	0.00	0.00	0.00	0.23	1.12	1.85	0.11	28.99	0.34	99.81

TABLE 2: ZIRCON ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	ER2O3	Y2O3	THO2	UO2	P2O5	FE2O3	HF02	ZR02	MGO	AL2O3	SI02	TOTAL
A03	01	0.02	0.00	0.06	0.06	0.11	0.04	0.01	0.12	0.54	1.17	63.86	0.00	0.18	33.83	96.95
A03	02	0.03	0.00	0.03	0.10	0.22	0.12	0.42	0.24	0.74	1.54	62.86	0.00	0.15	33.56	97.66
A03	03	0.02	0.01	0.00	0.01	0.16	0.09	0.03	0.17	0.45	1.17	64.42	0.00	0.15	33.32	93.35
A03	04	0.02	0.00	0.00	0.13	0.22	0.13	0.18	0.12	0.07	1.67	63.74	0.00	0.14	33.59	100.52
A03	05	1.28	0.14	0.35	0.02	0.10	0.06	0.04	0.05	1.02	0.74	60.81	0.02	1.49	33.89	100.35
A03	06	0.06	0.00	0.05	0.00	0.15	0.08	0.03	0.09	2.66	1.09	59.78	0.01	1.72	34.28	100.38
A03	08	0.00	0.00	0.09	0.10	0.08	0.02	0.00	0.02	0.06	1.19	64.77	0.00	0.01	33.67	101.16
A03	09	0.00	0.00	0.00	0.01	0.16	0.06	0.02	0.15	0.20	1.27	64.52	0.00	0.04	33.59	101.17
A03	10	0.00	0.02	0.02	0.09	0.11	0.07	0.11	0.21	0.13	1.40	64.18	0.00	0.02	33.63	98.13
A04	01	0.02	0.00	0.06	0.09	0.16	0.02	0.06	0.10	0.02	1.05	63.51	0.00	0.27	34.64	100.17
A04	03	0.03	0.00	0.05	0.04	0.28	0.24	0.20	0.30	0.13	0.94	63.56	0.00	0.14	34.09	99.80
A04	07	0.00	0.01	0.00	0.00	0.14	0.06	0.08	0.12	0.07	1.17	63.92	0.00	0.00	34.43	100.14
A04	08	0.04	0.00	0.04	0.09	0.23	0.00	0.03	0.08	0.07	1.08	64.10	0.00	0.07	34.18	100.46
A04	10	0.00	0.00	0.06	0.08	0.14	0.02	0.02	0.16	0.04	0.91	64.50	0.00	0.00	34.08	101.20
A05	01	0.02	0.01	0.03	0.07	0.27	0.05	0.23	0.09	0.04	1.54	63.33	0.00	0.02	34.31	101.00
A05	02	0.00	0.00	0.00	0.09	0.04	0.07	0.05	0.00	0.01	1.37	64.23	0.00	0.02	34.13	100.19
A06	03	0.01	0.04	0.02	0.01	0.10	0.04	0.05	0.01	0.03	1.33	64.26	0.00	0.02	34.08	101.30
A06	06	0.00	0.01	0.00	0.04	0.08	0.03	0.07	0.12	0.03	1.56	64.26	0.00	0.12	33.67	98.08
A06	07	0.00	0.00	0.00	0.11	0.12	0.02	0.03	0.15	0.03	1.22	64.20	0.00	0.00	34.12	100.06
A06	08	0.00	0.01	0.03	0.01	0.10	0.00	0.06	0.05	0.03	1.68	64.22	0.00	0.02	33.79	99.97
A06	09	0.00	0.00	0.00	0.06	0.22	0.01	0.05	0.09	0.02	0.85	65.01	0.00	0.03	33.67	100.28
A06	10	0.01	0.01	0.04	0.06	0.05	0.01	0.00	0.08	0.01	1.21	64.62	0.01	0.01	33.88	99.94
A06	16	0.00	0.00	0.06	0.01	0.03	0.04	0.01	0.07	0.03	1.22	64.08	0.00	0.01	34.44	101.41
A07	03	0.05	0.05	0.00	0.01	0.11	0.00	0.01	0.13	0.00	1.39	65.47	0.00	0.00	32.77	97.14
A07	05	0.00	0.01	0.04	0.13	0.10	0.00	0.07	0.03	0.01	1.42	64.90	0.00	0.00	33.28	97.22
A07	06	0.00	0.02	0.05	0.01	0.15	0.01	0.06	0.15	0.07	1.60	64.57	0.00	0.24	33.06	95.45
A07	09	0.01	0.00	0.01	0.00	0.21	0.03	0.00	0.14	0.01	1.14	65.65	0.03	0.00	32.78	95.77
A07	10	0.00	0.00	0.07	0.04	0.16	0.02	0.04	0.19	0.02	1.57	64.62	0.00	0.01	33.26	96.36
A08	02	0.00	0.01	0.00	0.00	0.05	0.00	0.05	0.15	0.04	1.49	65.98	0.00	0.02	32.21	96.03
A08	04	0.01	0.00	0.00	0.01	0.08	0.02	0.00	0.13	0.02	0.73	66.80	0.00	0.01	32.18	95.28
A08	05	0.03	0.00	0.03	0.04	0.00	0.03	0.00	0.00	0.01	1.47	66.31	0.00	0.04	32.03	96.09
A08	06	0.00	0.00	0.01	0.09	0.09	0.03	0.11	0.29	0.00	1.50	65.55	0.00	0.01	32.31	96.69
A08	07	0.00	0.00	0.03	0.07	0.13	0.06	0.13	0.00	0.03	1.59	66.06	0.00	0.30	31.59	95.43
A08	09	0.00	0.00	0.00	0.13	0.38	0.02	0.04	0.22	0.02	1.22	66.07	0.01	0.01	31.88	95.25
A08	10	0.01	0.00	0.01	0.02	0.10	0.02	0.00	0.05	0.02	0.87	66.08	0.00	0.00	32.81	95.85
A09	07	0.00	0.00	0.01	0.03	0.05	0.04	0.04	0.04	0.04	1.33	65.62	0.00	0.01	32.78	94.91
A09	08	0.00	0.00	0.06	0.00	0.05	0.02	0.04	0.00	0.13	1.23	64.58	0.00	0.65	33.24	95.70
A09	10	0.00	0.02	0.05	0.05	0.03	0.00	0.01	0.00	0.03	1.20	65.44	0.00	0.00	33.16	95.98
A10	06	0.02	0.00	0.07	0.08	0.31	0.31	0.35	0.39	0.11	2.00	63.21	0.01	0.27	32.85	96.32
A10	07	0.00	0.02	0.07	0.10	0.32	0.06	0.05	0.36	0.00	1.25	64.36	0.00	0.00	33.40	97.36
B01	01	0.01	0.00	0.00	0.08	0.14	0.01	0.17	0.16	0.07	1.41	63.92	0.00	0.11	33.92	99.45
B01	03	0.00	0.00	0.00	0.00	0.02	0.03	0.04	0.03	0.00	1.07	64.62	0.00	0.00	34.18	99.56
B02	02	0.00	0.04	0.08	0.03	0.16	0.02	0.05	0.11	0.20	1.36	63.54	0.00	0.01	34.41	100.73
B02	03	0.01	0.00	0.04	0.03	0.09	0.04	0.05	0.01	0.03	1.21	63.61	0.00	0.00	34.88	99.28
B02	04	0.00	0.00	0.00	0.19	0.04	0.02	0.01	0.13	0.02	1.37	63.53	0.01	0.01	34.67	98.78
B02	06	0.01	0.00	0.00	0.07	0.12	0.04	0.03	0.12	0.04	0.97	63.52	0.00	0.02	35.04	96.85
B02	07	0.00	0.00	0.00	0.10	0.05	0.02	0.05	0.07	0.03	1.52	63.11	0.00	0.00	35.04	98.46
B02	08	0.00	0.00	0.02	0.08	0.27	0.00	0.10	0.38	0.03	1.22	63.40	0.00	0.00	34.50	98.62
B02	09	0.00	0.00	0.04	0.05	0.05	0.00	0.02	0.03	0.03	1.39	64.35	0.00	0.00	34.04	99.44
B02	10	0.00	0.01	0.00	0.06	0.14	0.01	0.00	0.13	0.02	1.56	63.38	0.00	0.00	34.68	98.51
B03	01	0.01	0.05	0.02	0.01	0.11	0.04	0.05	0.13	0.32	1.58	63.07	0.00	0.10	34.49	91.55
B03	03	0.00	0.03	0.03	0.04	0.03	0.00	0.00	0.09	0.07	1.70	62.97	0.00	0.02	35.01	96.65
B03	06	0.01	0.07	0.00	0.04	0.27	0.01	0.02	0.32	0.09	1.31	62.40	0.00	0.01	35.45	97.16
B03	07	0.01	0.00	0.00	0.00	0.02	0.02	0.03	0.16	0.28	1.43	61.28	0.00	0.87	35.89	92.26

TABLE 2: ZIRCON ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	ER2O3	Y2O3	THO2	UO2	P2O5	FE2O3	HF02	ZR02	MGO	AL2O3	SI02	TOTAL
B03	09	0.00	0.04	0.02	0.06	0.09	0.00	0.00	0.08	0.09	1.32	62.99	0.00	0.01	35.30	98.02
B03	10	0.02	0.06	0.00	0.05	0.05	0.00	0.00	0.09	0.15	1.32	62.96	0.00	0.02	35.28	96.37
B04	05	0.01	0.00	0.01	0.05	0.15	0.05	0.08	0.14	0.05	1.35	62.54	0.00	0.20	35.36	97.72
B05	06	0.00	0.04	0.00	0.09	0.48	0.00	0.26	0.66	0.18	2.52	62.15	0.00	0.10	33.50	98.26
B05	07	0.01	0.01	0.03	0.11	0.17	0.04	0.08	0.28	0.05	1.57	62.01	0.00	0.02	35.61	98.26
B05	09	0.00	0.00	0.03	0.13	0.08	0.02	0.02	0.12	0.01	1.54	63.55	0.00	0.01	34.48	99.24
C01	11	0.00	0.00	0.00	0.00	0.07	0.00	0.06	0.15	0.03	0.60	65.43	0.00	0.01	33.66	89.00
C01	14	0.02	0.06	0.09	0.00	0.06	0.02	0.03	0.06	0.03	0.95	65.31	0.00	0.01	33.36	88.47
C01	15	0.00	0.00	0.00	0.00	0.08	0.01	0.04	0.10	0.44	0.97	61.57	0.34	0.52	35.94	89.02
C01	16	0.03	0.00	0.08	0.00	0.11	0.03	0.02	0.12	0.05	0.97	65.14	0.01	0.01	33.41	88.45
C01	19	0.02	0.01	0.02	0.03	0.02	0.00	0.02	0.05	0.05	1.00	65.76	0.00	0.00	33.02	88.26
C02	02	0.01	0.00	0.02	0.00	0.09	0.00	0.07	0.17	0.01	1.25	64.26	0.00	0.16	33.96	88.93
C02	04	0.57	0.00	0.00	0.07	0.20	0.01	0.06	0.46	0.05	1.09	63.40	0.00	0.05	34.04	88.72
C04	08	0.00	0.01	0.03	0.04	0.03	0.02	0.03	0.09	0.04	1.28	64.36	0.00	0.02	34.05	94.02
C04	10	0.01	0.00	0.00	0.03	0.04	0.00	0.03	0.27	0.03	1.23	64.15	0.00	0.04	34.16	93.47
C05	01	0.00	0.00	0.00	0.08	0.20	0.02	0.02	0.25	0.03	1.44	64.00	0.00	0.01	33.95	93.14
C05	02	0.00	0.00	0.03	0.09	0.12	0.03	0.02	0.14	0.03	1.04	65.07	0.00	0.00	33.42	92.51
C05	03	0.01	0.02	0.02	0.01	0.07	0.01	0.00	0.11	0.01	0.84	64.58	0.00	0.01	34.30	94.92
C05	05	0.01	0.01	0.03	0.03	0.00	0.01	0.03	0.12	0.01	0.91	64.95	0.00	0.01	33.87	93.85
C05	06	0.02	0.02	0.00	0.09	0.28	0.04	0.41	0.29	0.00	1.72	63.51	0.00	0.06	33.56	93.59
C05	07	0.00	0.01	0.00	0.04	0.02	0.00	0.03	0.05	0.03	0.83	65.13	0.00	0.00	33.85	94.84
C05	10	0.02	0.05	0.01	0.00	0.02	0.00	0.00	0.07	0.02	1.03	64.77	0.00	0.01	33.98	94.22
C06	01	0.01	0.02	0.00	0.04	0.04	0.00	0.03	0.00	0.10	1.31	63.95	0.05	0.09	34.35	92.60
C06	06	0.02	0.00	0.02	0.01	0.13	0.00	0.01	0.25	0.06	0.96	65.51	0.00	0.00	33.02	90.45
C06	09	0.00	0.00	0.00	0.00	0.13	0.03	0.02	0.11	0.03	0.98	65.32	0.02	0.07	33.29	91.06
C06	10	0.01	0.00	0.00	0.03	0.13	0.05	0.07	0.13	0.02	1.11	63.96	0.00	0.14	34.34	92.04
C07	01	0.09	0.01	0.09	0.01	0.18	0.01	0.25	0.36	0.95	2.36	60.82	0.12	1.13	33.62	88.85
C07	02	0.00	0.00	0.04	0.04	0.02	0.06	0.03	0.06	0.01	1.11	65.86	0.00	0.00	32.77	90.15
C07	03	0.01	0.00	0.09	0.08	0.05	0.00	0.02	0.11	0.03	0.96	64.79	0.00	0.05	33.80	91.09
C07	04	0.00	0.00	0.03	0.01	0.10	0.07	0.09	0.09	0.00	1.25	65.16	0.01	0.00	33.18	89.41
C07	05	0.03	0.01	0.00	0.01	0.09	0.01	0.08	0.12	0.03	1.48	64.34	0.00	0.00	33.80	89.45
C07	06	0.01	0.00	0.01	0.04	0.06	0.00	0.00	0.10	0.00	1.01	65.35	0.00	0.02	33.39	89.91
C07	07	0.01	0.07	0.01	0.00	0.04	0.01	0.06	0.07	0.02	0.79	62.04	0.00	0.13	36.74	89.55
C07	08	0.01	0.01	0.00	0.07	0.03	0.02	0.03	0.08	0.02	1.08	66.00	0.00	0.01	32.63	89.16
C07	09	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	1.29	66.20	0.00	0.00	32.47	89.43
C07	10	0.03	0.00	0.01	0.04	0.06	0.00	0.09	0.04	0.02	1.40	65.22	0.00	0.00	33.08	89.15
D01	01	0.00	0.09	0.02	0.00	0.08	0.06	0.08	0.07	0.00	1.25	65.25	0.00	0.02	33.09	90.30
D01	02	0.01	0.00	0.08	0.00	0.11	0.10	0.09	0.14	0.06	1.08	65.03	0.00	0.03	33.27	87.90
D01	03	0.03	0.00	0.00	0.12	0.28	0.11	0.10	0.13	0.17	0.76	65.50	0.00	0.22	32.56	89.19
D01	05	0.00	0.00	0.01	0.00	0.12	0.00	0.00	0.08	0.01	0.84	65.85	0.00	0.01	33.08	90.95
D01	06	0.00	0.00	0.03	0.00	0.07	0.02	0.00	0.12	0.01	0.69	66.25	0.00	0.01	32.79	89.67
D01	07	0.00	0.06	0.01	0.03	0.14	0.02	0.00	0.14	0.00	0.83	66.11	0.01	0.01	32.63	89.67
D01	08	0.04	0.00	0.06	0.00	0.15	0.03	0.03	0.18	0.01	0.91	65.77	0.00	0.01	32.80	89.63
D01	09	0.00	0.03	0.02	0.00	0.41	0.07	0.03	0.20	0.03	0.74	66.05	0.00	0.00	32.41	89.56
D01	10	0.00	0.00	0.07	0.00	0.11	0.18	0.07	0.08	0.02	0.97	65.70	0.00	0.00	32.81	90.47
D01	11	0.00	0.01	0.00	0.00	0.20	0.06	0.06	0.15	0.04	0.80	66.26	0.00	0.02	32.40	89.45
D02	02	0.00	0.00	0.03	0.02	0.20	0.03	0.06	0.09	0.06	1.06	65.72	0.00	0.00	32.73	89.77
D02	06	0.00	0.02	0.10	0.09	0.06	0.03	0.09	0.12	0.03	1.26	65.65	0.00	0.01	32.53	89.52
D02	07	0.01	0.00	0.04	0.18	0.14	0.07	0.07	0.08	0.02	1.22	65.26	0.00	0.00	32.90	89.85
D03	07	0.02	0.00	0.05	0.03	0.05	0.00	0.05	0.08	0.03	2.13	64.86	0.00	0.02	32.67	87.17
D04	01	0.01	0.01	0.00	0.04	0.01	0.05	0.02	0.13	0.02	1.37	64.72	0.00	0.00	33.62	94.12
D04	02	0.01	0.02	0.04	0.02	0.04	0.00	0.01	0.04	0.00	1.21	64.46	0.00	0.01	34.12	93.96
D04	03	0.01	0.00	0.03	0.07	0.11	0.01	0.00	0.18	0.00	0.79	64.67	0.00	0.00	34.13	93.96
D04	05	0.01	0.03	0.06	0.00	0.08	0.01	0.03	0.14	0.00	1.09	64.33	0.01	0.00	34.19	94.17

TABLE 2: ZIRCON ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	ER2O3	Y2O3	THO2	UO2	P2O5	FE2O3	HF02	ZR02	MGO	AL2O3	SI02	TOTAL
D04	06	0.01	0.00	0.07	0.01	0.06	0.04	0.03	0.10	0.03	0.90	64.80	0.00	0.00	33.94	94.35
D04	07	0.04	0.03	0.04	0.07	0.16	0.12	0.20	0.43	0.13	1.08	63.67	0.00	0.32	33.71	91.63
D04	08	0.00	0.05	0.05	0.05	0.03	0.00	0.10	0.04	0.03	1.35	64.41	0.00	0.00	33.87	93.74
D04	09	0.01	0.00	0.03	0.03	0.08	0.01	0.05	0.11	0.02	1.19	63.65	0.00	0.00	34.80	94.73
D04	10	0.01	0.00	0.01	0.04	0.07	0.03	0.00	0.06	0.03	1.18	64.20	0.00	0.00	34.35	94.58
E01	01	0.01	0.00	0.02	0.15	0.16	0.00	0.04	0.02	0.02	1.08	62.71	0.00	0.00	35.79	89.21
E01	03	0.02	0.00	0.06	0.03	0.11	0.08	0.06	0.07	0.03	1.22	62.31	0.00	0.02	35.99	90.13
E01	04	0.00	0.01	0.06	0.11	0.14	1.09	0.14	0.18	0.02	1.19	61.74	0.00	0.01	35.31	90.74
E01	05	0.00	0.00	0.04	0.04	0.11	0.02	0.10	0.13	0.03	1.47	62.44	0.00	0.02	35.58	90.87
E01	06	0.01	0.01	0.03	0.06	0.10	0.03	0.07	0.18	0.00	1.40	62.45	0.00	0.00	35.67	90.30
E01	07	0.00	0.02	0.00	0.12	0.04	0.00	0.00	0.15	0.20	1.10	62.09	0.02	0.53	35.72	91.04
E01	09	0.00	0.00	0.07	0.03	0.09	0.03	0.04	0.04	0.39	1.67	62.03	0.00	0.18	35.42	89.34
E01	10	0.02	0.02	0.00	0.22	0.20	0.06	0.11	0.29	0.01	0.96	63.38	0.00	0.00	34.72	83.23
E02	06	0.00	0.00	0.01	0.07	0.00	0.00	0.01	0.01	0.04	1.53	62.49	0.00	0.00	35.84	82.61
E02	07	0.03	0.00	0.05	0.08	0.29	0.09	0.20	0.48	0.27	1.91	60.94	0.00	0.43	35.23	78.63
E02	09	0.02	0.00	0.00	0.07	0.09	0.01	0.04	0.06	0.02	1.70	62.38	0.00	0.01	35.59	82.22
E02	10	0.04	0.05	0.00	0.06	0.05	0.04	0.00	0.01	0.04	1.28	63.16	0.00	0.00	35.28	82.63
E03	02	0.02	0.00	0.01	0.00	0.10	0.02	0.00	0.14	0.07	1.76	62.09	0.00	0.02	35.75	83.39
E03	04	0.00	0.02	0.00	0.09	0.16	0.05	0.06	0.23	0.02	2.05	61.68	0.00	0.01	35.65	88.82
E03	09	0.01	0.00	0.00	0.07	0.07	0.00	0.05	0.09	0.00	1.90	61.80	0.00	0.00	36.01	88.78
E04	01	0.00	0.00	0.02	0.09	0.00	0.02	0.01	0.14	0.02	1.12	62.61	0.00	0.01	35.95	87.32
E04	05	0.03	0.01	0.00	0.09	0.23	0.08	0.08	0.19	0.32	1.43	62.77	0.01	0.08	34.70	78.94
E04	06	0.00	0.00	0.00	0.23	0.38	0.03	0.15	0.16	0.03	1.50	61.96	0.00	0.09	35.45	86.52
E04	08	0.00	0.06	0.05	0.17	0.08	0.02	0.06	0.20	0.14	1.45	62.22	0.02	0.03	35.50	88.23
E04	09	0.01	0.00	0.00	0.20	0.27	0.06	0.05	0.08	0.02	1.63	62.28	0.00	0.01	35.40	86.66
E05	06	0.02	0.01	0.02	0.05	0.06	0.01	0.02	0.09	0.03	1.71	62.63	0.01	0.02	35.31	87.96
E05	07	0.00	0.03	0.00	0.06	0.10	0.02	0.07	0.10	0.05	1.47	63.00	0.00	0.01	35.09	88.38
E05	10	0.02	0.01	0.01	0.10	0.16	0.00	0.02	0.14	0.03	1.39	63.83	0.00	0.00	34.27	86.86
E06	07	0.02	0.01	0.06	0.15	0.21	0.15	0.22	0.22	0.03	1.63	62.22	0.00	0.03	35.06	87.31
E06	08	0.01	0.00	0.05	0.16	0.08	0.06	0.16	0.13	0.04	1.68	63.33	0.00	0.05	34.25	82.68
E07	06	0.05	0.02	0.02	0.31	0.07	0.12	0.52	0.34	1.87	7.94	57.11	0.00	0.38	31.25	88.36
E07	07	0.01	0.02	0.00	0.03	0.23	0.01	0.66	0.17	0.05	2.08	61.66	0.00	0.00	35.08	88.80
E07	08	0.01	0.02	0.01	0.17	0.00	0.01	0.03	0.00	0.20	1.59	59.47	0.06	1.52	36.90	88.71
E08	03	0.01	0.00	0.00	0.13	0.22	0.06	0.26	0.26	0.18	2.16	60.99	0.00	0.06	35.67	85.05
E08	05	0.00	0.01	0.04	0.19	0.04	0.06	0.00	0.09	0.00	1.18	62.44	0.00	0.01	35.95	85.32
F05	01	0.00	0.00	0.02	0.05	0.04	0.01	0.05	0.00	0.11	1.22	62.73	0.00	0.17	35.62	84.57
F05	02	0.01	0.00	0.07	0.05	0.16	0.21	0.08	0.08	0.06	0.98	62.23	0.00	0.00	36.08	87.77
F05	05	0.02	0.00	0.07	0.09	0.10	0.06	0.11	0.00	0.14	1.36	63.54	0.00	0.02	34.48	80.60
G02	01	0.01	0.00	0.02	0.08	0.03	0.02	0.02	0.05	0.01	1.19	63.00	0.00	0.00	35.57	86.91
G02	02	0.02	0.02	0.07	0.09	0.05	0.02	0.06	0.06	0.03	1.56	62.18	0.00	0.00	35.84	86.72
G02	03	0.12	0.00	0.01	0.08	1.08	0.11	0.22	1.54	0.13	1.37	60.64	0.00	0.31	34.38	83.07
G02	04	0.00	0.00	0.00	0.10	0.05	0.04	0.00	0.12	0.04	1.47	62.77	0.00	0.01	35.42	83.82
G02	05	0.01	0.00	0.05	0.08	0.08	0.02	0.17	0.12	0.04	2.58	61.23	0.00	0.00	35.62	84.42
G02	06	0.02	0.00	0.00	0.04	0.14	0.07	0.05	0.08	0.05	1.10	62.30	0.04	0.12	35.99	84.41
G03	01	0.00	0.00	0.00	0.04	0.05	0.00	0.00	0.12	0.00	1.22	62.59	0.01	0.01	35.97	85.24
G03	02	0.00	0.02	0.08	0.17	0.10	0.00	0.13	0.23	0.01	1.80	61.16	0.00	0.01	36.29	83.42
G03	03	0.18	0.00	0.04	0.10	0.06	0.04	0.06	0.10	0.02	1.29	61.88	0.00	0.00	36.24	83.93
G03	04	0.00	0.00	0.04	0.19	0.08	0.02	0.05	0.05	0.01	1.74	62.13	0.00	0.01	35.67	82.74
G03	05	0.00	0.00	0.03	0.13	0.08	0.01	0.06	0.14	0.04	1.53	62.32	0.00	0.05	35.63	79.24
G03	06	0.00	0.00	0.00	0.17	0.19	0.04	0.07	0.10	0.02	1.64	62.31	0.00	0.01	35.44	80.41
G03	07	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.10	0.01	1.27	62.98	0.00	0.00	35.62	83.22
G03	08	0.00	0.00	0.05	0.05	0.09	0.01	0.05	0.04	0.01	1.03	62.72	0.00	0.02	35.94	84.65
G03	09	0.01	0.00	0.06	0.04	0.05	0.00	0.00	0.28	0.01	1.34	61.58	0.00	0.28	36.35	79.78
G03	10	0.00	0.04	0.00	0.01	0.05	0.01	0.01	0.07	0.00	1.06	62.90	0.00	0.01	35.83	85.48

TABLE 2: ZIRCON ANALYSES NORMALIZED TO 100 PERCENT

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	CAO	LA2O3	CE2O3	ER2O3	Y2O3	THO2	UO2	P2O5	FE2O3	HF02	ZR02	MGO	AL2O3	SI02	TOTAL
G03	11	0.01	0.01	0.02	0.12	0.02	0.01	0.04	0.08	0.01	1.39	62.17	0.00	0.00	36.11	84.96
H01	01	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.09	0.00	0.90	64.69	0.00	0.01	34.27	92.20
H01	03	0.00	0.00	0.04	0.09	0.13	0.00	0.25	0.32	0.03	1.57	64.47	0.00	0.10	32.99	90.91
H01	06	0.00	0.00	0.05	0.00	0.23	0.02	0.03	0.08	0.10	0.80	64.39	0.00	0.01	34.28	91.16
H01	08	0.00	0.00	0.03	0.07	0.08	0.03	0.01	0.05	0.03	0.95	64.61	0.02	0.02	34.09	90.97
H02	01	0.01	0.00	0.00	0.01	0.04	0.03	0.03	0.10	0.02	1.02	65.08	0.00	0.01	33.64	90.51
H02	02	0.01	0.00	0.02	0.00	0.04	0.02	0.02	0.03	0.02	0.76	65.93	0.00	0.01	33.12	89.19
H02	03	0.00	0.00	0.06	0.01	0.04	0.01	0.01	0.02	0.01	1.13	65.07	0.00	0.00	33.64	90.26
H02	05	0.58	0.05	0.03	0.01	0.20	0.01	0.05	0.53	0.00	1.06	64.82	0.00	0.01	32.65	88.66
H02	06	0.02	0.00	0.02	0.06	0.27	0.08	0.03	0.17	0.05	0.96	64.55	0.00	0.05	33.75	88.60
H02	08	0.00	0.00	0.01	0.00	0.14	0.02	0.01	0.11	0.02	1.22	65.57	0.00	0.01	32.88	90.26
H02	10	0.03	0.00	0.06	0.00	0.14	0.00	0.00	0.10	0.01	0.94	65.05	0.00	0.01	33.66	90.06
H03	01	0.01	0.00	0.10	0.00	0.00	0.01	0.07	0.07	0.03	1.65	64.83	0.00	0.00	33.22	87.80
H03	02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.01	1.13	65.05	0.00	0.00	33.66	89.22
H03	04	0.00	0.00	0.00	0.01	0.02	0.00	0.05	0.07	0.02	1.07	65.89	0.00	0.01	32.86	87.98
H03	08	0.11	0.00	0.00	0.11	0.55	0.05	0.38	1.26	0.12	1.52	64.51	0.01	0.24	31.16	85.10
H03	10	0.00	0.06	0.02	0.14	0.41	0.07	0.05	0.16	0.01	0.97	65.26	0.00	0.00	32.86	88.44
H04	02	0.00	0.00	0.00	0.10	0.23	0.02	0.03	0.15	0.20	0.88	65.64	0.00	0.00	32.74	86.31
H04	03	0.02	0.00	0.00	0.00	0.13	0.02	0.08	0.01	0.02	1.01	65.32	0.00	0.00	33.38	86.96
H04	06	0.00	0.00	0.06	0.08	0.22	0.00	0.06	0.07	0.05	0.73	65.25	0.00	0.01	33.47	87.11
H04	07	0.00	0.00	0.10	0.03	0.15	0.02	0.03	0.03	0.06	0.97	65.43	0.00	0.00	33.16	87.37
H04	09	0.01	0.00	0.00	0.00	0.05	0.02	0.00	0.08	0.10	1.09	65.38	0.00	0.02	33.24	86.40
H04	10	0.00	0.01	0.00	0.07	0.06	0.06	0.00	0.07	0.28	0.78	65.15	0.00	0.01	33.52	88.31
H05	04	0.00	0.00	0.01	0.08	0.23	0.13	0.07	0.08	0.00	1.17	66.77	0.01	0.01	31.44	85.70
H06	05	0.00	0.08	0.00	0.05	0.12	0.08	0.07	0.10	0.03	0.97	66.25	0.00	0.01	32.24	86.58
H06	06	0.02	0.02	0.00	0.05	0.02	0.00	0.02	0.09	0.07	1.08	66.90	0.00	0.22	31.49	84.59
H06	07	0.02	0.00	0.00	0.01	0.00	0.03	0.01	0.05	0.02	1.27	66.15	0.00	0.02	32.40	86.54
H06	08	0.00	0.06	0.05	0.04	0.06	0.01	0.04	0.05	0.02	1.15	66.36	0.00	0.02	32.14	82.86
H06	09	0.01	0.01	0.08	0.07	0.14	0.08	0.02	0.00	0.01	0.83	65.83	0.00	0.00	32.90	86.37

TABLE 3: MONAZITE ANALYSES, NOT NORMALIZED
TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES

SITE	GRAIN	CAO	LA2O3	CE2O3	ER2O3	Y2O3	THO2	UO2	P2O5	FE2O3	HF02	ZR02	AL2O3	SI02	TOTAL
A03	01	0.54	15.49	30.10	0.14	1.50	9.63	0.46	26.21	0.01	0.00	0.19	0.15	2.06	86.48
A03	02	0.48	15.38	28.62	0.04	0.92	16.47	0.84	24.55	0.00	0.00	0.16	0.00	3.60	91.06
A03	04	0.40	17.07	31.84	0.04	1.13	7.81	0.33	26.65	0.21	0.00	0.25	0.42	1.95	88.10
A03	05	0.39	17.55	34.40	0.02	1.47	5.89	0.49	28.76	0.00	0.00	0.11	0.02	1.11	90.21
A03	10	0.41	17.40	32.31	0.00	1.25	8.12	0.44	26.57	0.23	0.00	0.08	0.05	1.61	88.47
A06	11	1.18	15.77	31.64	0.17	2.42	2.86	0.40	28.75	0.00	0.00	0.02	0.01	0.14	83.36
A06	12	0.96	16.72	32.24	0.12	2.14	4.10	0.45	29.54	0.00	0.00	0.16	0.00	0.22	86.65
A06	13	0.97	17.25	32.77	0.12	1.92	4.71	0.58	29.64	0.00	0.00	0.14	0.00	0.36	88.46
A06	14	0.58	16.04	33.84	0.08	2.13	3.20	0.52	29.48	0.00	0.00	0.23	0.02	0.32	86.44
A06	15	0.98	15.51	31.39	0.01	2.12	5.18	0.82	28.60	0.00	0.00	0.18	0.01	0.40	85.20
A06	17	1.14	16.71	33.95	0.05	0.72	4.86	0.76	29.65	0.00	0.00	0.00	0.02	0.14	88.00
A06	18	0.76	16.19	31.87	0.01	2.62	3.70	0.59	29.30	0.00	0.00	0.08	0.00	0.27	85.39
A06	19	0.96	16.46	30.53	0.10	2.82	4.78	0.95	29.30	0.00	0.00	0.06	0.00	0.37	86.33
A06	20	0.90	16.32	32.41	0.12	2.13	5.12	0.67	28.97	0.00	0.00	0.15	0.00	0.61	87.40
A07	11	1.15	15.95	32.27	0.00	1.59	4.33	0.55	28.53	0.00	0.00	0.75	0.01	0.41	85.54
A07	13	1.61	14.99	30.38	0.00	1.74	8.41	0.45	28.82	0.00	0.01	0.02	0.00	0.28	86.71
A07	14	1.29	15.72	31.87	0.03	1.68	5.88	0.82	29.11	0.00	0.00	0.18	0.01	0.20	86.79
A07	16	1.15	17.47	32.89	0.00	0.90	6.71	0.20	28.39	0.00	0.08	0.09	0.00	0.42	88.30
A07	17	1.05	16.45	32.59	0.10	1.78	5.33	0.41	29.49	0.00	0.00	0.05	0.00	0.19	87.44
A07	18	0.91	16.40	32.00	0.10	2.61	4.16	0.76	28.97	0.00	0.03	0.06	0.00	0.15	86.15
A07	19	1.25	15.24	30.54	0.10	2.44	6.30	0.60	28.87	0.00	0.00	0.04	0.00	0.25	85.63
A07	20	0.53	17.47	35.13	0.02	0.70	2.41	0.41	28.78	0.00	0.00	0.13	0.00	0.10	85.68
A08	11	0.59	16.62	31.94	0.09	2.01	2.86	0.82	28.68	0.00	0.00	0.16	0.00	0.24	84.01
A08	12	0.77	15.96	31.89	0.03	2.10	5.08	0.75	28.38	0.00	0.00	0.00	0.00	0.42	85.38
A08	13	0.60	16.66	32.82	0.08	1.57	3.54	0.46	27.99	0.00	0.07	0.15	0.00	0.25	84.19
A08	14	0.71	16.43	32.10	0.02	2.26	4.04	0.56	28.61	0.00	0.00	0.13	0.01	0.31	85.18
A08	15	0.79	15.83	32.20	0.09	1.92	4.20	0.85	28.70	0.00	0.00	0.06	0.01	0.25	84.90
A08	16	1.11	14.46	30.54	0.07	2.07	5.52	0.67	27.98	0.49	0.00	0.15	0.25	0.43	83.74
A08	17	0.63	15.91	32.65	0.06	2.16	3.87	0.47	29.10	0.00	0.00	0.07	0.14	0.37	85.43
A08	18	0.89	18.13	33.64	0.08	1.21	3.91	0.45	27.54	0.00	0.00	0.11	0.00	0.37	86.33
A08	19	0.99	15.50	31.26	0.11	2.39	4.51	0.92	29.13	0.00	0.00	0.00	0.00	0.18	84.99
A08	20	0.75	17.10	33.00	0.13	1.50	4.29	0.36	28.97	0.00	0.00	0.06	0.00	0.25	86.41
A10	15	0.91	16.55	31.74	0.03	2.15	3.77	1.23	28.85	0.00	0.00	0.02	0.00	0.21	85.46
B01	01	1.31	17.46	32.06	0.03	1.57	2.34	0.60	28.59	0.00	0.00	0.07	0.02	0.13	84.18
B02	01	1.44	16.66	31.84	0.04	2.04	5.51	0.52	29.05	0.00	0.00	0.08	0.01	0.23	87.42
B02	02	1.68	16.29	31.62	0.04	2.58	3.22	0.51	28.62	0.00	0.00	0.20	0.00	0.19	84.95
B02	03	1.24	16.32	31.36	0.07	1.92	5.41	0.79	28.78	0.00	0.00	0.00	0.00	0.35	86.24
B02	04	1.03	16.94	32.63	0.06	1.94	4.90	0.28	28.86	0.00	0.00	0.14	0.02	0.20	87.00
B02	05	1.31	15.92	32.70	0.04	2.07	4.72	0.52	29.39	0.00	0.04	0.00	0.00	0.13	86.84
B02	06	1.17	17.35	33.48	0.16	2.10	4.26	0.22	29.25	0.00	0.00	0.09	0.00	0.13	88.21
B02	08	0.14	18.19	38.19	0.02	1.07	0.23	0.29	28.99	0.00	0.00	0.00	0.00	0.10	87.22
B02	09	1.28	14.83	28.39	0.04	1.68	6.09	0.73	26.82	3.40	0.00	0.10	1.53	2.23	87.12
B02	10	1.35	17.67	33.88	0.03	1.31	4.52	0.54	29.53	0.00	0.11	0.89	0.02	0.14	89.99
B03	03	0.96	16.82	34.76	0.00	0.63	4.43	0.72	28.86	0.00	0.00	0.05	0.00	0.17	87.40
B03	07	1.06	15.73	33.81	0.00	0.84	5.74	0.42	28.48	0.00	0.00	0.29	0.01	0.28	86.66
B03	08	0.77	14.88	27.38	0.10	1.44	2.58	0.51	24.86	5.88	0.04	0.18	0.03	0.15	78.80
B03	09	0.84	14.57	32.87	0.00	0.24	8.24	0.27	26.89	0.00	0.00	0.03	0.02	1.04	85.01

TABLE 4: APATITE ANALYSES, NOT NORMALIZED

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES
ANALYSES A01-03 AND A01-04 ARE OF THE SAME GRAIN

SITE	GRAIN	CAO	LA2O3	CE2O3	ER2O3	Y2O3	THO2	UO2	P2O5	FE2O3	HF02	ZR02	MGO	AL2O3	SI02	TOTAL
A01	03	56.83	0.07	0.09	0.00	0.04	0.01	0.01	45.37	0.04	0.00	0.19	0.00	0.00	0.03	102.68
A01	04	56.70	0.07	0.18	0.00	0.05	0.00	0.00	42.76	0.04	0.01	0.07	0.00	0.01	0.06	99.95
A01	06	56.76	0.00	0.08	0.00	0.01	0.01	0.01	42.90	0.02	0.01	0.19	0.00	0.00	0.04	100.03
A01	07	55.39	0.05	0.15	0.01	0.05	0.00	0.00	42.34	0.09	0.00	0.21	0.00	0.04	0.05	98.38
A01	08	55.50	0.02	0.03	0.06	0.04	0.01	0.00	42.02	0.07	0.00	0.14	0.01	0.08	0.07	98.05
A02	03	57.30	0.00	0.00	0.03	0.00	0.00	0.00	42.17	0.06	0.00	0.24	0.00	0.03	0.07	99.90
A02	06	57.22	0.00	0.01	0.00	0.00	0.00	0.00	41.98	0.08	0.00	0.14	0.00	0.10	0.25	99.78
A04	08	57.09	0.11	0.17	0.04	0.02	0.01	0.01	41.30	0.04	0.00	0.25	0.00	0.01	0.19	99.24
C01	02	48.82	0.03	0.00	0.00	0.12	0.01	0.01	57.01	0.00	0.00	0.19	0.00	0.01	0.06	86.26
C01	03	49.03	0.00	0.04	0.00	0.01	0.01	0.01	58.31	0.02	0.08	0.14	0.00	0.01	0.01	87.67
C01	08	49.30	0.01	0.05	0.00	0.17	0.00	0.02	57.71	0.04	0.00	0.12	0.00	0.00	0.12	87.54
C06	08	50.78	0.00	0.05	0.05	0.14	0.02	0.01	59.13	0.05	0.02	0.27	0.00	0.01	0.06	90.59
D04	04	53.54	0.01	0.00	0.00	0.00	0.02	0.01	59.51	0.03	0.00	0.18	0.01	0.00	0.04	93.35
E08	10	50.36	0.03	0.00	0.04	0.03	0.00	0.00	33.58	0.05	0.03	0.09	0.00	0.02	0.07	84.30
F06	04	54.12	0.06	0.04	0.03	0.11	0.01	0.03	35.53	0.06	0.00	0.12	0.02	0.01	0.21	90.35
F06	10	52.24	0.00	0.03	0.02	0.19	0.01	0.01	35.55	0.06	0.00	0.08	0.00	0.00	0.04	88.23

TABLE 5: MONAZITE ANALYSES NORMALIZED TO 100 PERCENT (SPOT ANALYSES)

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

SITE	GRAIN	POINT	CAO	LA2O3	CE2O3	PR2O3	ND2O3	SM2O3	EU2O3	GD2O3	ER2O3	DY2O3	Y2O3	THO2	UO2	P2O5	F	TOTAL
B02	01	01	0.80	15.44	31.41	2.82	11.74	1.64	0.00	1.22	0.07	0.11	0.42	5.06	0.37	28.49	0.39	107.88
B02	01	02	0.94	15.50	31.42	2.84	10.83	1.79	0.03	1.38	0.07	0.18	0.45	5.05	0.31	28.73	0.47	108.23
B02	02	01	0.88	14.81	29.85	2.68	11.63	1.82	0.13	1.73	0.17	0.59	1.40	4.33	0.44	29.04	0.50	106.05
B02	02	02	0.83	15.57	30.71	2.61	10.91	1.71	0.18	1.47	0.22	0.56	1.46	3.91	0.61	28.79	0.47	107.29
B02	03	01	1.40	12.80	27.29	2.69	10.34	2.24	0.23	2.26	0.32	0.74	2.00	7.52	0.49	29.21	0.46	106.46
B02	03	02	1.47	12.85	27.58	2.75	10.49	2.13	0.15	2.06	0.12	0.65	2.28	7.42	0.50	29.11	0.44	106.00
B02	03	03	1.40	13.48	27.17	2.51	10.31	2.42	0.09	1.99	0.39	0.69	2.01	7.35	0.52	29.25	0.43	105.78
B02	04	01	1.15	15.36	30.27	2.62	10.69	1.74	0.05	1.52	0.25	0.34	1.18	4.73	0.50	29.06	0.55	106.09
B02	05	01	1.00	15.70	29.56	2.69	11.12	1.88	0.22	1.61	0.14	0.62	1.59	4.07	0.59	28.77	0.44	106.27
B02	06	01	1.16	16.20	30.22	2.72	10.51	1.42	0.08	0.97	0.20	0.23	1.23	6.02	0.31	28.30	0.42	102.67
B02	07	01	1.16	15.35	28.73	2.84	10.62	1.44	0.12	1.35	0.15	0.70	1.84	5.78	0.75	28.76	0.42	107.26
B02	07	02	0.97	15.15	29.63	2.59	10.62	1.43	0.18	1.57	0.22	0.60	1.82	5.00	0.66	29.13	0.43	105.30
B02	07	03	0.94	14.50	29.90	2.75	10.90	1.91	0.18	1.59	0.21	0.63	1.87	4.59	0.66	28.97	0.39	106.75
B02	08	01	1.00	14.26	29.49	2.92	11.65	2.31	0.35	1.77	0.19	0.57	2.08	3.28	0.58	29.07	0.47	105.39
B02	09	01	0.96	15.79	30.68	3.19	10.91	1.56	0.00	1.16	0.08	0.15	0.68	5.61	0.15	28.59	0.48	106.74
B02	10	01	1.10	15.36	29.71	2.90	9.86	1.68	0.18	1.41	0.32	0.58	1.67	5.40	0.46	28.94	0.42	105.18
F02	04	01	1.20	14.38	28.34	2.67	10.20	2.26	0.00	1.83	0.23	0.51	1.40	6.14	1.99	28.38	0.48	104.64
F02	04	02	1.07	13.45	28.69	2.66	11.52	2.47	0.09	2.09	0.08	0.35	0.98	6.68	0.90	28.58	0.40	105.40
F02	04	03	1.29	13.65	28.62	2.75	11.46	2.39	0.00	1.51	0.00	0.46	1.25	7.00	0.89	28.19	0.55	105.63
F02	04	04	1.61	13.55	27.14	2.80	11.56	2.10	0.00	0.71	0.00	0.69	1.93	9.24	2.01	26.24	0.41	92.18
F02	04	05	1.48	13.69	27.99	2.88	10.71	2.12	0.05	1.88	0.18	0.62	1.46	6.32	1.39	28.76	0.48	105.54
F02	04	06	1.43	13.07	27.36	2.45	10.31	2.05	0.00	1.70	0.24	0.71	1.22	8.62	1.66	28.80	0.38	104.14
F02	04	07	1.29	14.40	28.41	2.55	11.11	2.25	0.03	1.80	0.16	0.53	1.02	6.06	1.37	28.61	0.42	105.53
F02	04	08	1.21	13.98	28.70	2.73	10.99	2.30	0.00	1.93	0.20	0.58	1.02	5.98	1.28	28.69	0.41	106.13
F02	04	09	1.43	14.71	27.77	2.54	9.83	1.92	0.00	1.64	0.22	0.47	1.52	6.17	2.44	28.88	0.45	105.78
F02	04	10	1.41	14.77	28.13	2.61	9.86	2.00	0.00	1.22	0.18	0.43	1.47	6.01	2.60	28.81	0.49	104.62
F02	04	11	1.41	15.27	29.22	2.71	9.95	1.84	0.00	0.99	0.00	0.43	1.12	6.53	2.31	27.80	0.43	102.77
F02	04	12	1.13	13.95	28.73	2.73	11.06	2.17	0.00	2.06	0.17	0.26	0.99	5.80	1.38	29.12	0.44	103.98
F02	04	13	1.22	13.97	28.20	2.84	11.40	2.19	0.05	1.96	0.09	0.37	0.90	6.05	1.43	28.85	0.46	105.41
F02	04	14	1.48	12.93	27.66	2.79	10.39	2.05	0.00	1.63	0.26	0.56	1.63	8.37	1.60	28.32	0.32	104.48
F02	04	15	1.20	13.86	28.47	2.75	10.82	2.25	0.00	2.07	0.15	0.49	1.13	6.47	1.45	28.44	0.45	106.01
F02	04	16	1.57	13.33	27.48	2.71	10.56	1.72	0.00	0.54	0.00	0.39	1.52	8.84	1.65	29.26	0.42	102.93
F02	04	17	1.36	14.22	28.43	2.73	10.71	1.94	0.00	0.45	0.00	0.42	1.29	7.03	1.47	29.52	0.42	102.38
F02	04	18	1.26	14.24	30.18	2.95	11.26	1.95	0.00	0.36	0.00	0.57	0.89	5.93	1.30	28.70	0.41	102.25
F02	04	19	1.18	14.00	28.41	2.83	11.14	2.14	0.00	2.07	0.13	0.38	1.02	6.11	1.30	28.82	0.48	104.98
F02	04	20	1.19	14.08	28.53	2.89	10.89	2.23	0.00	1.73	0.15	0.45	0.97	5.93	1.47	29.01	0.46	105.52

TABLE 6: STATISTICS OF MONAZITE ANALYSES NORMALIZED TO 100 PERCENT
TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	C.V.
CAO	180	0.881	0.268	0.310	1.560	30.385
LA203	180	15.148	1.461	11.180	20.060	9.644
CE203	180	30.102	1.672	25.230	35.630	5.554
PR203	180	2.835	0.181	2.330	3.330	6.386
ND203	180	11.188	0.918	8.760	13.700	8.203
SM203	180	1.790	0.450	0.560	3.190	25.162
EU203	180	0.034	0.070	0.000	0.360	208.571
GD203	180	1.228	0.580	0.000	2.680	47.253
ER203	180	0.137	0.115	0.000	0.420	83.603
DY203	180	0.403	0.266	0.000	1.130	65.900
Y203	180	1.369	0.824	0.160	3.020	60.203
THO2	180	5.195	2.058	1.630	16.680	39.609
UO2	180	0.705	0.427	0.020	2.460	60.575
P2O5	180	28.571	0.784	24.670	29.830	2.744
F	180	0.413	0.096	0.200	0.700	23.162
TOTAL	180	105.873	4.875	88.050	113.140	4.604

TABLE 7: STATISTICS OF MONAZITE ANALYSES, NOT NORMALIZED

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	C.V.
CAO	47	0.934	0.335	0.140	1.680	35.834
LA2O3	47	16.347	0.912	14.460	18.190	5.578
CE2O3	47	32.220	1.771	27.380	38.190	5.496
ER2O3	47	0.059	0.047	0.000	0.170	79.124
Y2O3	47	1.734	0.598	0.240	2.820	34.500
THO2	47	5.058	2.435	0.230	16.470	48.139
UO2	47	0.574	0.214	0.200	1.230	37.223
P2O5	47	28.464	1.149	24.550	29.650	4.038
FE2O3	47	0.217	0.981	0.000	5.880	451.046
HF02	47	0.008	0.023	0.000	0.110	285.603
ZR02	47	0.131	0.164	0.000	0.890	125.263
AL2O3	47	0.059	0.231	0.000	1.530	389.827
SI02	47	0.509	0.690	0.100	3.600	135.604
TOTAL	47	86.316	1.992	78.800	91.060	2.308

TABLE 8: STATISTICS OF ZIRCON ANALYSES NORMALIZED TO 100 PERCENT
TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES USED FOR NORMALIZATION

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	C.V.
CAO	191	0.024	0.110	0.000	1.280	455.395
LA2O3	191	0.011	0.020	0.000	0.140	185.503
CE2O3	191	0.028	0.036	0.000	0.350	130.076
ER2O3	191	0.058	0.055	0.000	0.310	94.203
Y2O3	191	0.123	0.117	0.000	1.080	95.297
THO2	191	0.040	0.088	0.000	1.090	220.588
UO2	191	0.066	0.092	0.000	0.660	139.128
P2O5	191	0.140	0.166	0.000	1.540	118.544
FE2O3	191	0.094	0.265	0.000	2.660	282.379
HF02	191	1.303	0.591	0.600	7.940	45.352
ZR02	191	63.941	1.611	57.110	66.900	2.519
MGO	191	0.005	0.027	0.000	0.340	584.827
AL2O3	191	0.085	0.236	0.000	1.720	276.015
SiO2	191	34.078	1.227	31.160	36.900	3.601
TOTAL	191	91.354	5.600	78.630	101.410	6.130

TABLE 9: STATISTICS OF APATITE ANALYSES, NOT NORMALIZED

TOTAL = THE SUM OF THE ORIGINAL OXIDE PERCENTAGES

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	C.V.
CAO	16	53.811	3.244	48.820	57.300	6.029
LA2O3	16	0.029	0.034	0.000	0.110	117.697
CE2O3	16	0.057	0.061	0.000	0.180	105.787
ER2O3	16	0.017	0.021	0.000	0.060	120.769
Y2O3	16	0.061	0.064	0.000	0.190	103.923
THO2	16	0.007	0.007	0.000	0.020	91.084
UO2	16	0.008	0.008	0.000	0.030	102.667
P2O5	16	39.823	3.299	33.580	45.370	8.285
FE2O3	16	0.047	0.023	0.000	0.090	49.708
HFO2	16	0.009	0.021	0.000	0.080	221.938
ZRO2	16	0.164	0.061	0.070	0.270	37.239
MGO	16	0.002	0.006	0.000	0.020	230.940
AL2O3	16	0.021	0.030	0.000	0.100	143.249
SI02	16	0.086	0.070	0.010	0.250	81.804
TOTAL	16	94.144	6.178	84.300	102.680	6.562

TABLE 10: LATITUDE AND LONGITUDE OF SITES IN DECIMAL DEGREES

SITE	LAT	LONG
A01	33.378	82.947
A02	33.433	83.044
A03	33.521	83.105
A04	33.601	83.189
A05	33.671	83.266
A06	33.775	83.365
A07	33.829	83.418
A08	33.910	83.512
A09	33.976	83.595
A10	34.067	83.692
B01	34.642	83.770
B02	34.572	83.708
B03	34.494	83.630
B04	34.404	83.533
B05	34.344	83.473
C01	35.395	83.520
C02	35.291	83.488
C03	35.219	83.424
C04	35.129	83.374
C05	35.037	83.332
C06	34.953	83.255
C07	34.846	83.176
D01	34.164	82.577
D02	34.242	82.610
D03	34.319	82.649
D04	34.401	82.695
E01	34.983	82.643
E02	34.907	82.563
E03	34.823	82.479
E04	34.746	82.390
E05	34.669	82.318
E06	34.620	82.249
E07	34.510	82.163
E08	34.430	82.116
F01	35.217	81.438
F02	35.272	81.534
F03	35.339	81.632
F04	35.407	81.760
F05	35.476	81.877
G01	34.847	80.587
G02	34.641	80.233
G03	34.715	80.387
G04	34.762	80.474
G05	34.780	80.525
H01	33.763	81.002
H02	33.836	81.106
H03	33.905	81.238
H04	33.960	81.343
H05	34.001	81.443
H06	34.046	81.519
H07	34.099	81.633

TABLE 11. SUPPLEMENTARY MONAZITE ANALYSES NORMALIZED TO 100 PERCENT.

TOTAL = THE SUM OF THE ORIGINAL OXIDE ANALYSES USED FOR NORMALIZATION.

SITE	GRAIN	CAO	LA2O3	CE2O3	PR2O3	ND2O3	SM2O3	EU2O3	GD2O3	ER2O3	DY2O3	Y2O3	THO2	UO2	F	P2O5	SI02	ZR02	TOTAL
A03	07	1.16	15.23	24.27	0.48	11.30	1.48	0.00	1.06	0.12	0.12	0.49	12.39	0.86	1.36	27.69	1.97	0.00	97.25
A03	08	0.59	15.69	29.49	0.81	14.56	2.16	0.00	0.00	0.03	0.04	0.50	3.99	0.65	1.11	29.83	0.55	0.00	96.01
A03	09	1.14	14.93	24.40	2.55	10.53	1.54	0.00	1.19	0.00	0.17	0.44	12.58	0.92	0.60	27.13	1.89	0.00	98.99
A03	10	0.79	15.70	26.71	2.60	9.13	1.51	0.00	1.02	0.23	0.19	1.10	11.84	0.51	2.82	23.71	2.15	0.00	100.37
A03	11	0.47	16.48	29.80	2.76	10.01	1.28	0.00	0.90	0.77	0.00	1.46	5.39	0.38	3.81	25.32	1.05	0.13	101.95
A03	12	0.50	16.63	28.69	2.69	9.17	1.43	0.00	0.94	0.59	0.14	1.19	9.33	0.38	2.42	24.17	1.66	0.08	100.46
A03	13	0.55	16.78	28.62	2.66	9.46	1.20	0.00	1.06	1.05	0.08	1.68	7.94	0.34	2.98	24.09	1.42	0.09	100.37
A03	14	0.40	17.50	31.15	2.80	10.68	1.33	0.00	0.63	0.02	0.10	0.95	6.32	0.19	0.11	26.23	1.39	0.19	91.42
A03	15	0.44	16.19	27.95	2.66	9.84	1.77	0.00	1.24	0.55	0.27	1.30	8.20	0.33	3.79	23.90	1.46	0.12	101.97
A03	16	0.47	15.90	28.44	2.32	9.17	1.29	0.00	0.86	0.68	0.23	1.25	11.02	0.44	2.04	23.78	2.03	0.07	99.14
A03	17	0.51	15.49	27.36	2.60	9.77	1.67	0.04	1.37	0.73	0.31	1.53	8.39	0.31	3.33	24.77	1.69	0.13	100.90
A03	18	0.50	16.39	30.22	2.64	10.16	1.42	0.02	1.03	0.86	0.41	1.99	4.80	0.49	2.16	25.94	0.85	0.13	100.97
E04	11	1.24	14.30	28.02	2.97	11.07	1.76	0.00	1.27	0.27	0.22	1.96	6.30	0.93	1.19	27.78	0.71	0.00	95.72
E04	12	1.17	14.16	27.92	2.83	11.08	1.56	0.00	1.20	0.25	0.22	1.88	5.86	0.82	3.46	26.83	0.76	0.00	98.32
E04	13	0.78	14.82	28.80	2.50	10.67	1.63	0.00	1.24	0.21	0.36	1.02	8.03	0.32	2.47	25.46	1.47	0.22	99.49
E04	14	1.56	13.69	26.52	2.62	10.65	1.71	0.00	1.62	0.32	0.70	2.58	6.45	1.51	1.54	27.94	0.58	0.00	96.07
E04	15	0.98	14.70	28.95	2.63	11.07	2.12	0.20	1.90	0.31	0.75	2.97	2.90	1.40	0.69	28.08	0.35	0.00	95.91
E04	16	1.22	14.31	28.45	2.68	10.75	1.78	0.00	1.21	0.37	0.40	1.29	7.09	1.01	1.90	26.65	0.88	0.00	97.59
G03	22	1.11	13.98	27.76	2.57	11.24	2.18	0.07	1.76	0.37	0.56	2.38	3.93	1.24	3.74	26.65	0.47	0.00	99.59
G03	23	0.82	15.34	31.56	2.67	10.68	1.94	0.00	1.30	0.23	0.30	0.94	6.02	0.38	0.98	25.82	1.01	0.00	94.72
G03	24	1.11	14.40	29.57	2.94	11.01	2.06	0.00	1.60	0.36	0.62	2.92	3.80	0.87	1.23	27.03	0.48	0.00	97.53
G03	25	1.12	13.93	29.36	2.75	11.35	2.28	0.00	1.72	0.22	0.41	1.93	5.55	0.55	1.52	26.67	0.66	0.00	97.65
G03	26	1.24	14.76	30.86	2.98	11.82	2.29	0.05	1.87	0.14	0.18	0.93	4.40	0.67	0.86	26.48	0.46	0.01	98.33
G03	27	1.05	15.22	29.97	3.08	12.31	2.25	0.06	1.48	0.16	0.33	0.73	4.40	0.55	1.04	26.84	0.50	0.03	97.37
G03	28	1.15	14.13	30.18	2.70	12.52	2.07	0.00	1.93	0.24	0.42	1.17	4.37	0.72	1.49	26.36	0.46	0.11	98.59

TABLE 12

Supplementary Zircon Analyses, Not Normalized

		SiO ₂	ZrO ₂	FeO	HfO ₂	Total
E03	1A Core	29.15	65.31	.13	.84	95.43
E03	1B	29.53	63.78	.10	.58	94.00
E03	1C	29.14	62.18	0.00	.33	91.66
E03	1D	28.13	62.62	0.00	.53	91.28
E03	1E	27.66	62.56	.08	.56	90.86
E03	1F Edge	27.71	65.46	.14	1.33	94.64
E03	1D2	28.34	69.08	0.00	1.78	99.20
E03	2	31.42	69.69	.08	1.20	102.39
E03	3	32.37	68.81	.19	.63	102.01
E03	4	29.33	68.74	.03	1.52	99.62
E03	5	30.49	66.63	.14	.82	98.07
E03	6	27.29	63.12	.25	.75	91.43
E03	7	25.81	61.00	.31	.83	87.99
E03	8	29.79	63.01	0.00	.36	95.37
E03	9	27.67	63.65	0.00	1.01	92.33
E03	10	28.36	66.52	0.00	1.23	96.13
E07	1A Core	28.95	65.57	.03	1.16	95.56
E07	1B Rim	28.41	66.26	.08	1.15	96.03
E07	1C Rim	29.07	64.77	0.00	.99	94.58
E07	2A Core	30.65	66.54	.06	.84	98.04
E07	2B	27.43	63.80	0.00	1.74	94.81
E07	2C	27.81	65.86	0.00	1.64	95.06
E07	2D	30.08	66.33	.22	1.00	97.62
E07	2E	28.92	65.21	.12	1.20	95.45
E07	3	27.06	65.06	.19	1.56	93.87
E07	4	29.11	65.53	.04	1.13	95.82
E07	5	30.18	65.63	.11	.76	96.80
E07	6A	28.79	65.80	0.00	1.15	95.84
E07	6B	27.30	64.22	.05	1.58	93.17
E07	7	27.96	66.36	.22	1.67	96.20
E07	8	27.47	65.16	.04	1.53	94.20
E07	9	29.60	67.21	.16	1.05	98.03
E07	10	27.82	65.44	.25	1.36	94.92
G02	1	27.52	65.35	0.00	1.46	94.36
G02	2	30.88	66.69	.03	.68	98.28
G02	3	29.93	66.30	.10	.91	97.31
G02	4	30.26	65.77	0.00	.77	96.81
G02	5	30.30	64.48	0.00	.69	95.47
G02	6	28.30	65.27	0.00	1.21	94.78
G02	7	28.45	62.24	.12	.91	92.09
G02	8	30.84	66.27	.27	.64	98.17
G02	9	28.14	64.61	.08	1.24	94.05
G02	10	30.00	64.58	0.00	.76	95.34
G02	11	32.30	65.23	.03	.15	97.71
G02	12	30.84	65.42	.01	.45	96.73
G02	13A Core	28.75	64.98	.04	.88	94.65
G02	13B	28.51	65.93	0.00	1.18	95.61
G02	13C	29.21	66.30	0.00	.98	96.49
G02	13D	28.39	66.23	0.00	1.26	95.88
G02	13E Edge	28.43	65.59	.01	1.05	95.08
G02	13F Edge	27.45	64.86	.02	1.30	93.63
G02	14	29.36	67.32	.07	1.11	97.86
G02	15	31.22	66.22	0.00	.43	97.87
G02	16	27.85	66.97	.13	1.77	96.72